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A MONOGRAPH

OF

THE PERMIAN FOSSILS

OF

ENGLAND.

BY

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INTRODUCTION.

The fossils described in the following pages belong, for the most part, to a series of deposits overlying the North of England Coal-measures, and passing under the Midland Saliferous marls, and sandstones. These three groups of deposits represent distinct consecutive geological systems; the lowest or most ancient one representing the Carboniferous; the highest or most recent one, the Triassic; and the intermediate one, the Permian. The rocks of the Permian system were deposited during the latest division of the Protozoic or Primary organic period; and those of the Triassic, in the earliest division of the Deuterozoic or Secondary period. The separation between these two great periods is based on the prevailing idea, that Organic Nature underwent a most marked change at the time the Permian rocks were being deposited: this may, or may not have been the case; at any rate, the prevalence of the idea invests the fossil remains of the rocks in question with the utmost importance in philosophical geology.

Although a few earlier brief notices appeared descriptive of the deposits immediately connected with the province of this Monograph, it was not until the Rev. Professor Sedgwick published his admirable Memoir 'On the Geological relations and Internal Structure of the Magnesian Limestone,' that they became properly appreciated. The edifice so ably reared for England, by one of the illustrious founders of Modern Geology, has of late had its parallel erected for a far distant region, by another, whose name is as inseparably connected with the early history of this ennobling science.

Investigating the Geology of Russia, Sir Roderick I. Murchison, with his colleagues M. de Verneuil, and Count Keyserling, discovered in Perm, and the adjoining countries on the Western or European flanks of the Ural Mountains, an extensive group of rocks, consisting of Limestones, Gypseous and Saliferous marls, and repeated alternations of Cupreous grits, containing numerous fossils intermediate in character between those respectively belonging to the Carboniferous, and the Triassic system. At the completion of their investigations, Sir R. Murchison became fully convinced, that the rocks in question were the exact equivalents of the Todte-liegende, Mergel-schiefer, and Zechsteins of Germany; and of the Lower New Red Sandstone, Marl-slate, and Magnesian Limestones of England,—our home deposits having been previously demonstrated to be of the same geological age as those just named occurring in Germany.

The extensive development of these deposits in the Government of Perm, where they occupy an area twice the size of France,—their containing a far more copious and

varied suite of fossils than was known to occur in the contemporaneous rocks of England, or Germany,—their having no proper distinctive general title, except such as were obviously inappropriate,—and in consideration of the general reception and fitness of geographical names for co-ordinate groups, as exemplified by those previously in use, —Sir R. Murchison was induced to apply to these deposits the term *Permian*, which, it will be perceived, is derived from the name of the country in which they are most extensively developed.

The Permian system, as developed in the North of England, is divisible into six distinct members, having the following order of superposition.

a. Crystalline, earthy, compact, and oolitic limestones.
b. Brecciated, and pseudo-brecciated limestones.
c. Fossiliferous limestone.
d. Compact limestone.
e. Marl-slate.
f. Various coloured sandstones.

By traversing certain districts in the County of Durham, the above order of position will be observed. Thus, passing from the edge of the limestone near Bolden direct to the coast, we meet with, at the base of the Cliff on the west side of Down Hill, a bed of freestone,—the lowest member of the series (*f*); next the overlying Marl-slate (*e*), on which repose several beds of brown-coloured limestone (*d*), the lowest of which are flaggy, and the highest gritty and imperfectly concretionary. Following the direction of the dip of these deposits, that is, towards the coast, we first meet with beds of light-coloured limestone (*c*), containing numerous organic remains, as at Hylton-North-Farm, and Southwick-Lane-House: this is succeeded in the ascending order, as in the West Quarry at Southwick, by a variety of beds generally of a brecciated and pseudo-brecciated character (*b*); and these in their turn become overlaid by vast beds of crystalline and other limestones (*a*), extensively worked in the Fulwell Quarries, and continued down to Roker Cliffs on the coast, where they are lost in the German Ocean. It often happens that this order of superposition is obscured by some of the beds becoming modified in character, or some of the members being absent. The inferior limestone (*d*) is, in some places, compact, and of a uniform dark gray colour (Midderidge); in other places it is deep brown, imperfectly concretionary, thin bedded, and sometimes cellular (Harton, &c.); and in a few others mottled, and ribboned with various shades of brown and gray (Pallion): it also varies in chemical composition, consisting in general simply of carbonate of lime, to which is added, in a few localities, (Ferry-Hill, Johnston,) a considerable portion of carbonate of magnesia. The highest member of the series (*a*) is another deposit, varying even more decidedly in its characters: a bed at one place may be crystalline, compact, and ash-coloured; and at a few yards distance, earthy,

yellow, and more or less charged with coralloidal, botryoidal, and other crystalline forms (Building Hill): in one district, this deposit splits into flexible laminæ, as thin as paper (Marsden); in another it is dull, fine grained, compact, and thick bedded; and at a few paces off, it is glimmering and completely crystallised: this member also varies in chemical composition; inasmuch as the crystalline portions are entirely composed of carbonate of lime; while the earthy, which form the principal mass of the deposit, are essentially magnesio-calcareous in their composition.

As regards those cases in which one or more members of the system are wanting, a reference may be advantageously made to the section at Tynemouth Cliff, which exhibits the following deposits in the order represented:

Pseudo-brecciated limestone.

True brecciated do.[1]

Beds of Freestone.[2]

Now I am led to conclude, that in this section, three members of the series are absent;—namely, the Marl-slate (*e*), the Compact limestone (*d*), and the Fossiliferous limestone (*c*). My reasons for this conclusion are; 1st, the true brecciated bed contains fragments of brown-coloured limestone, identical with that which occurs at Down Hill, and other places along the Permian escarpment, north and south of this locality; 2d, it contains fragments of the fossiliferous limestone;[3] and 3d, the Marl-slate is entirely absent. The breccia was clearly not formed until after the deposition and complete consolidation of those members the débris of which it contains. A parallel case appears to obtain at Claxheugh, where the brecciated or pseudo-brecciated limestone (*b*) is seen overlying the sandstone (*f*). In several places, the Marl-slate only is absent; as in the Cliff on the south side of Cullercoats Bay; though at a few yards to the north, between tide marks, near the line of the 90 Fathom Dyke, the Marl-slate (here coloured black, with carbonaceous matter, as in the adjacent quarry at Whitley) is distinctly seen intercalated between the sandstone, and the flaggy beds of brown limestone.

The order of superposition of the Permian beds is instructively displayed in several

[1] This bed encloses large boulders of limestone (some of which are two feet in diameter) in the centre of the cliff; but at the north end it completely loses its brecciated character, and becomes quite arenaceous and compact.

[2] This bed is a true conglomerate, enclosing some rather large angular boulders of purple-coloured freestone.

[3] I only succeeded in finding two or three specimens of fossiliferous limestone in the breccia at Tynemouth Cliff; and these yielded me the following fossils:—*Fenestella retiformis, Synocladia virgulacea, Acanthocladia anceps, Cyathocrinus ramosus, Productus horridus, Strophalosia Goldfussi, S. excavata, S. Morrisiana, Streptorhynchus pelargonatus, Camarophoria Schlotheimi, S. globulina, Trigonotreta cristata, T. undulata, Cleiothyris pectinifera, Epithyris elongata, E. sufflata, Pecten pusillus, Monotis speluncaria, Bakevellia ceratophaga, Pleurophorus costatus,* and *Pleurotomaria antrina.*

places between the Wear and the Tees.[1] The railway cutting at Thrislington Gap exhibits, in the ascending scale, the Sandstone, Marl-slate, and Compact limestone. These members are exposed in the same relative position at several places north and south of this locality; and, by following them in the direction of their dip, they are seen to pass beneath the other members of the series. The shaft sunk near the quarry at Humbleton Hill for supplying the New Water-works of Sunderland, shows that this Hill rests on a gritty limestone, with imperfect concretions, identical with that reposing on the flaggy beds of brown limestone at Down Hill: this gritty limestone has its uppermost beds exposed in the adjoining Lime-kiln Hole; and these beds, which contain a few fossils, such as *Pleurophorus costatus*, *Leda Vinti*, &c., are there seen to be surmounted by a thick magnesio-calcareous bed, which has been quarried for a number of years, and is clearly identical with the fossiliferous limestone (*c*) already noticed, as occurring at Hylton-North-Farm. By passing over the intervening valley to Tunstall Hill, the fossiliferous limestone is again met with; but, in following the axis of this hill, it is soon observed to be overlaid by a non-fossiliferous calcareous rock, which either passes, or becomes changed, into the brecciated or pseudo-brecciated deposit exposed at the foot of Tunstall Hope: this is continued down to the coast, where it forms the bold and singular Cliffs extending from the Gorge near Ryhope, south to beyond Seaham harbour. Half a mile north of Ryhope Gorge, at the south end of the Crags, the breccia is seen to rise from beneath the highest member of the series,—the crystalline limestone (*a*), which is traced northward to Sunderland, where it forms the entire mass of those varied and singular beds constituting the low rounded eminence well known by the name of Building Hill. Numerous excavations in Bishopwearmouth have convinced me, that the crystalline limestone passes downwards into the brecciated rocks exposed in the Cliffs of the river Wear above the bridge, and at Galley's Gill, precisely as at the Southwick quarries and the south end of the Crags. I only know of one place on the coast, south of the Wear, where any other member of the series appears to be exposed, which is at the north end of Black Hall Rocks; and here occurs a breccia containing fossils the same as those characteristic of the fossiliferous limestone of Humbleton Hill and Hylton-North-Farm, and passing under the highest member of the series (*a*), which forms the remainder of these "Rocks" to their southern termination. The beds at the south end of Black Hall Rocks have very much the aspect of the dull compact thick-bedded limestone occurring in several places on the coast between the Tyne and the Wear; and they contain its characteristic fossils, namely *Schizodus Schlotheimi*, *Mytilus septifer*, *&c.* At Hartlepool, the southernmost coast point of the Permian limestone, the Cliffs consist principally of the oolitic variety of the highest member—a variety which also occurs between tide marks, opposite Sunderland, and near Roker Baths north of the Wear, associated with botryoidal, and other crystalline

[1] Permian fossiliferous limestones also occur in a few places a little south of the Tees; but I have not had an opportunity of examining them properly.

forms of limestone,—in both of which places it has yielded me specimens of the above-named shells. Probably the brecciated beds at the north end of Black Hall Rocks, like those at Tynemouth Cliff, are partly formed of the débris of the fossiliferous limestone, true beds of which are seen, at little more than a mile distance, in Castle-Eden-Dene.

The conditions under which the Permian Rocks of the North of England have been formed, are worthy of investigation. The lowest member of the series, the freestone (*f*), like arenaceous deposits in general, appears to have been accumulated in shallow water: this view is to a certain extent proved by the presence of land plants in some of its beds, as at Westoe; and by the surface of other beds being in some places (Thrislington Gap) crowded with strong ripple marks. In some localities, as at Tynemouth, it appears to have been accumulated in a violently agitated sea,—perhaps on a coast margin,—some of its beds containing large angular fragments of a purple-coloured sandstone, and having quite the character of a conglomerate. The Marl-slate (*e*) is apparently another shallow water or littoral deposit; as it contains, in addition to *Algæ*, the remains of Ferns (*Neuropteris Huttoniana*) at Thickley, and Thrislington Gap. The fishes, with which it is everywhere loaded, also attest its littoral origin; as the genera which characterise it, namely, *Palæoniscus*, *Pygopterus*, *Cœlacanthus*, and *Platysomus*, from their abundance in certain Coal-measure deposits, those of Yorkshire in particular, may be safely concluded to have lived at no great distance from the shore. The presence in the Thuringian equivalent of the English Marl-slate of *Lingula Credneri*, *Discina speluncaria*, *Productus horridus*, *Camarophoria Schlotheimi*, *Pleurophorus costatus*, *Bakevellia antiqua*, *Fenestella retiformis*, and probably some other species, *if they were generally numerous*, might be considered as strongly opposing this conclusion. The next member of the system,—Compact limestone (*d*), concluding from its mineralogical and chemical characters, and from the fragile nature of many of its organic remains (Acanthocladias, Strophalosias, &c., Whitley), appears to be a pelagic deposit. The same conclusion may be safely advanced with respect to the overlying member, the Fossiliferous limestone (*c*); for it is impossible to conceive, that such delicate organisms, as the numerous Ciliobrachiate Corals, and spiney Palliobranchs imbedded in it, could have existed any where except in deep water. In nearly all the localities where this limestone is seen, it has a very irregular structure, and scarcely offers any appearance of stratification: it is clearly a chemical deposit; and from the circumstances noticed, I am strongly disposed to regard it as having been formed, or rather precipitated, in a very rapid manner. The brecciated member (*b*) has evidently been deposited under unusual circumstances: it nowhere contains fragments of any other than Permian limestone; but the size of these fragments, measuring, in some localities, two feet in diameter (Tynemouth Cliff), and weighing, in others, several tons (Ryhope), indicates, however contiguous the parent bed from which they were torn may have been, that they were heaped together by powerful cataclysmal agencies. The next and last member of the series, the Crystalline member (*a*), possesses, in its often finely laminated character, that is, when observed in its normal or unaltered

condition, internal evidence of having been deposited in a sea little affected by disturbing influences. It also appears to have been formed in shallow water; since the surface of some of its beds, between tide water marks, opposite Sunderland,[1] is as distinctly rippled as the alluvial sand accumulated in the immediate vicinity. The entire absence of Corals, and Palliobranchiate shells in these beds, may perhaps be adduced as another argument in favour of the view which has been advanced: besides, such shells as *Mytilus septifer*, *Schizodus Schlotheimi*, &c., which they exclusively contain, might be instanced as another accordant evidence.

The internal structure of the last-noticed member, constitutes a most important subject in lithological Geology. It may be safely stated, that few rocks in the entire series of stratified formations present such singular and varied aspects as are often displayed by the uppermost member of the Permian System in the County of Durham. Some of its beds are as different from what they were originally, as the most decided metamorphic rocks. This member, it has already been stated, consists of crystalline, earthy, compact, and oolitic limestones; but it will be more convenient for present purposes to say, that it consists of crystalline, and non-crystalline limestones. The former are largely developed at Building Hill, and several other places; the latter, at Hartlepool, and some other localities on the coast of Durham. The crystalline kinds consist chiefly of carbonate of lime; but the non-crystalline (oolitic), contain a large portion, as much as 44 per cent. (Johnston), of carbonate of magnesia in addition. Various hypotheses have been proposed to account for the presence of so large a quantity of carbonate of magnesia in the non-crystalline limestones: it is the general opinion, however (and I am quite in favour of the same view), that this substance is an original constituent of the rock, or, in other terms, that it was deposited at the same time as the carbonate of lime with which it is associated.[2] But the most singular circumstance connected with this member is, that the same bed is often crystalline and essentially calcareous in one part, and non-crystalline and magnesio-calcareous in another not a yard apart: nay, hand specimens display precisely the same molecular and chemical differences. In some localities, the crystalline limestones assume the most singular appearances, consisting of enormous branching radiating coral-like masses, or of globular, hemispherical, discoidal concretions, the latter varying from the size of a marble to that of the largest cannon-ball. The cause of these singular structures has ever been, and will probably long remain, a perplexing problem. None of the hypotheses hitherto advanced to account for them, appear to me to be satisfactory: this is considered a sufficient reason for my attempting to emulate previous writers in speculating on their origin.

Like most sedimentary rocks, the Protozoic especially, many of the beds of the Permian system, in addition to their natural partings, or those displayed on their lines of deposition or stratification, are very much and continuously intersected or divided by cleavage splits, varying extremely in their distance from each other. Now in brief terms, although the connexion is completely obscured in some places, I have generally found, that wherever the coralloidal, or globulo-concretionary structures are most distinctly developed, it is in the immediate vicinity of either the cleavage splits, or the deposition partings. A few years since, at Building Hill, near Sunderland, the quarrymen exposed several beds, which were completely divided into great irregular rhomboidal blocks, the form of which has resulted from the cleavage splits passing continuously and somewhat obliquely through the beds. In this particular instance, there were displayed the most singular and beautiful coralloidal forms I have ever seen. When one of these rhomboidal blocks was broken, it disclosed a number of dark brown radiately-branching coralloidal bodies striking off towards the

[1] This locality, which was immediately opposite the old battery, is now occupied by the new docks.

[2] Dr. Richardson is inclined to ascribe the formation of the constituents of the magnesian limestone "to the influx of waters holding chloride of magnesium in solution, which, meeting with calcareous matter held in solution by an excess of carbonic acid, robbed it of that excess, and the two carbonates of lime and magnesia fell together. (Vide Report Brit. Association, 1842, part ii, p. 37.)

centre (repeatedly pullulating similar bodies in their progress from all its sides), where they were the most numerously developed, regardless of the latter answering to the plane of a cleavage split, or of a deposition parting: the interspaces between the branches of the coralloidal bodies were filled with a yellow ochreous magnesio-calcareous powder; while the branches themselves were radiately crystallised, and essentially composed of carbonate of lime. Since the period referred to, I have seen similar phenomena in other places; as in the railway cutting between Sunderland and Ryhope, where the beds are distinctly divided by cleavage splits, from the walls of which, and also from those of the deposition partings, innumerable crystalline bodies, resembling the Music Pipe Coral, branch off in the most striking manner, giving the beds the appearance as if they were formed of vast petrified coral reefs. At Fulwell and Southwick quarries, where the beds have not been so decidedly acted on by cleavage forces, I have seen enormous stalactiticoid and mammillated masses shooting off, both upwards and downwards, base to base, from the plane of horizontal deposition partings,—the law of gravity having been altogether disregarded by the mysterious agent of their production. It required no effort of the mind to perceive, that the coralloidal and mammillated forms had been produced by one and the same agent, and that this agent had thus operated since the deposition and consolidation of the rock, nay, even subsequently to the completion of the cleavage structure. Other inferences, as the following, spontaneously flow from a right interpretation of the phenomena observed: 1st, the entire rock was originally magnesio-calcareous in its composition; 2d, the ochreous portions have not undergone any chemical or molecular change; 3d, the rock became divested of the magnesia when it assumed the crystalline form; 4th, the crystalline portions have undergone a complete chemical and molecular change.

But it may be asked—how, or in what manner, has this change—this metamorphism been produced? This is a question which I can only answer hypothetically. Apparently several circumstances have contributed to the change; namely, the chemical composition of the rock, cleavage splits, and deposition partings; for it is impossible to ward off the idea, that they are in some way or other connected with the coralloidal structures. The cleavage splits naturally direct our attention to *their* producing agent; but an important point requires to be settled before *it* can be made available in the present inquiry;—thus, is cleavage a mechanically or a physically induced structure? If the former, I should not be in the least disposed to invoke its aid; but if the latter, a powerful agent seems to be at our command. The cleavage agent, for the reason above stated, however, does not avail us in working out the problem under consideration. As a last resort,—no answer appears so satisfactory as the one suggested by the hypothesis, that some volatilising agent, in passing or circulating through the cleavage splits and deposition partings, has acted here and there on the original constituents of the rock, expelling the magnesia in such places, and crystallising the residual carbonate of lime; while the former constituent would remain associated with the calcareous base wherever the rock was not acted on. I am certainly more inclined to adopt this view than the one which maintains the change to have been produced by simple chemical segregation when the rock was in a soft state, as proposed by Professor Sedgwick; or that which contends for the partial permeation of the beds at any indefinite time after their formation, either by vapours of some form of magnesia evolved from subjacent igneous sources,[1] or by a magnesian solution effused from overlying oceanic reservoirs, as proposed by some other writers.

It may be objected, that this hypothesis does not explain the origin of the globulo-concretionary masses, which are often seen where the coralloidal structures are not developed. If these masses were decidedly isolated (in some cases the connexion between them is very slight), and in the heart of a pulverulent bed, without any connexion with the deposition partings, or cleavage splits, I admit that there would be some reason for withholding assent to it; but, as neither one, nor the other of these conditions prevails, this objection readily falls to the ground, whether it be based on what is displayed in the bed of "cannon-balls"

[1] The Sunderland Magnesian limestone has often been termed Dolomite; but until it is certain, that the magnesia of this deposit has originated in the same way as that of the true Dolomites of the Tyrol, it seems premature to make such a use of this mineralogical term. Respecting the origin of the magnesia contained

at Roker Cliff, or in the rock of "marbles" at Building Hill. In those beds which are almost entirely composed of crystalline carbonate of lime, as in the Bathing Cove at Byers's Quarry, and several other localities, it may be supposed, that the volatilising agent has acted on the *entire mass* of the rock.

I have been led into the foregoing observations, not so much from a desire to describe certain phenomena, as to give them a Palæontological bearing, which, to a certain extent, they appear to possess; because, from the published observations of Freiesleben[1] and Geinitz, it is suspected, that rocks displaying precisely the same characters, having the same relative position, and containing the same fossils, are developed in several localities in the Permian region of Thuringia. Do the rocks alluded to contain the fossils *Schizodus Schlotheimi, Mytilus septifer*, &c., to the exclusion of Palliobranchiate shells, and corals, as their equivalents in Durham?

The Permian members of the North of England do not complete the series;[2] as in the South of Yorkshire, Lancashire, Derbyshire, and Nottinghamshire, other rocks, occasionally consisting of variously coloured marls, with and without gypsum, exist, which are supposed to be more recent than the former, and which become obscured by seemingly being intermixed with, or apparently passing into, the Sandstones, and Saliferous marls of the overlying Triassic system. As much obscurity hangs over the Permian rocks of the Midland districts, it will be the safest plan to make no other than a mere incidental mention of them; and the same may be advantageously adopted with regard to the Derbyshire Magnesian Limestone containing *Productus horridus*, the Bristol Magnesian Conglomerate, and the so-called Permian rocks in South Wales, and some other deposits, supposed to be of the same age, in the neighbourhood of Dungannon and Belfast, Ireland. Certain members of the Permian system undoubtedly occur in Cumberland.[3]

in the Tyrolian Dolomites, the reader is referred to the hypothesis of Von Buch, and to some others lately proposed by Haidinger, Professor Favre, and Von Morlot, translations of which are given in the 'New Edinburgh Philosophical Journal' for January and July, 1849.

[1] Geognostischer Beiträg zur Kenntniss des Kupfer-schiefergebirges, vol. iv.

[2] I am inclined to think, that the remains of a higher member of the Permian system occur in the County of Durham; as during the excavation of the Newcastle and Sunderland railway, at a place between Fulwell toll-gate, and Monkwearmouth, the workmen exposed several large natural galleries passing through beds of marly limestone belonging to member *a*, and filled with a very fine pipe clay of various colours, as red, blue, yellow, and green. It occurs to me, that Professor Phillips (? Philosophical Magazine, 1828) has described something of the kind in the limestone quarries at Brotherton. I was prevented making any proper observations on these galleries in consequence of the workmen sodding the sides of the excavation shortly after it was made.

[3] The account herein given of the Permian members of the North of England has been derived from my own observations made some years since, assisted by Professor Sedgwick's Memoir, and another valuable paper, entitled 'Notes on the New Red Sandstone of the County of Durham below the Magnesian Limestone,' by Mr. William Hutton, and inserted in the 'Transactions of the Natural History Society of Northumberland, Durham, and Newcastle-on-Tyne,' vol. i, pp. 66-74. In some respects I differ from Professor Sedgwick, particularly as regards the origin of the crystalline structures, and the relative position of some of the beds; for example, those between Marsden and North Point on the coast of Durham, and the Fish bed in Pallion Quarry. My removal to Galway has prevented the latter point being further examined into, which was always my intention previously to finishing the present work: I cannot, therefore, maintain my views so strongly as could be desired: perhaps, were I going over the ground again, I might be led to modify them to a certain extent.

Our attention may, in the next place, be directed to the Permian rocks on the Continent of Europe. In Thuringia, these rocks hold exactly the same relative position as they do in the North of England: wherever the Carboniferous, or Triassic rocks are associated with the Permian deposits, these are seen overlying the former, and underlying the latter: the agreement is still further borne out in a more detailed point of view, as shown by the following comparative table of the constituent members of both the English and Thuringian Permians.

Members of the Thuringian Permians.	*Members of the North of England Permians.*
Stinkstein.	Crystalline, and Non-crystalline Limestone.
Rauchwacke.[1]	Brecciated, and Pseudo-brecciated ditto.
Dolomit.[2]	Fossiliferous ditto.
Zechstein.	Compact ditto.
Mergerl-schiefer.[3]	Marl Slate.
Todte-liegende.[4]	Inferior Sandstone.

The upper members of the Thuringian Permian rocks appear to assume the character of the English Midland Permians; and, like the latter, they often become obscurely blended with the overlying strata of the Triassic system. In other parts of Germany, as Saxony and Silesia, some, or all, of the same members are found; and they are met with still further to the east, particularly on the confines of European Russia, where they become somewhat modified. Count Keyserling having discovered true Permian rocks in Petschora-land, bordering the icy sea, it is extremely probable, as surmised by De Köninck, from an examination of their fossils, that M. Robert met with the same deposits in the still higher region of Spitzbergen.

The localities noticed afford indisputable evidence, that the Permian Ocean occupied an immense area, extending from Ireland to the Ural mountains, and probably to Spitzbergen, with its northern boundary line defined by the Carboniferous, Devonian, Silurian, and Igneous regions of Scotland, Scandinavia, and Northern

[1] I saw none of the beds of Rauchwacke and Stinkstein myself when in Thuringia; but from the description which Freiesleben gives of them, as abridged by M. d'Aubuisson de Voisins, (vide 'Traité de Géognosie,' tome i,) I have little or no doubt of their being the exact equivalents of the English brecciated, and pseudo-brecciated limestones, and of the crystalline (coralloidal, globulo-concretionary), earthy, compact, and oolitic limestones abounding in the county of Durham.

[2] This member has been variously named by German geologists. It is often called Upper Zechstein, Zechstein-dolomit. The bed which I saw of it at Schlossberge von Könitz, agrees most remarkably in colour, mineral and chemical characters, structure, and organic contents, with the one occurring at Humbleton and Tunstall Hills. Near Könitz, it reposes on beds (Zechstein), agreeing with the compact grey limestone at Thickley, Ferry-Hill, and other places.

[3] The principal difference between the Mergerl-schiefer and our Marl Slate is, that the former abounds in some places with argentiferous and other copper ores, in which case it is called Kupfer-schiefer.

[4] The Todte-liegende varies, like its English equivalent, in colours; when light coloured, it is called Weissliegende; when red, rothe-todte-liegende.

Russia, and its southern boundaries, apparently stretching far into the south of Europe. It is unsafe to speculate further on the extent of area overspread by the Ocean during the Permian period. Rocks said to contain Permian Fossils have been discovered in various parts of Asia; and others, supposed to agree in their organic contents with the English deposits, have been found in Nova Scotia. It would thus appear, that the Permian Ocean has been of vast extent,—encompassing a great portion of the Northern hemisphere.

As the Permian system immediately succeeded the Carboniferous, and was directly followed by the Triassic, it is reasonable to conclude, that the assemblage of organic remains characteristic of the first, in addition to its containing several new forms, embraced many which are identical with, or allied to, such as belong either to one or the other of the two latter systems. As regards their Flora, a comparison cannot be well entered into, in consequence of the comparative paucity of vegetable remains in at least one of the systems. The known plants of the Permian rocks consist of *Algæ*, Lepidodendrons, Calamites, Sigillarias, Ferns, and some doubtfully allied forms, termed *Nœggerathia*. The *Algæ* of the Carboniferous rocks are not sufficiently known to be compared with the numerous Caulerpa-like Fossils which are met with in the Mergerl-schiefer, and its English equivalent: the genus *Chondrus* apparently characterises both the lowest and the highest member,—*Chondrus Binneyi* having been found in the former, and *C. virgatus*, Münster, also a Kupfer-schiefer plant, in the upper-Zechstein of Altenburg. The existence of *Lepidodendron*—a common carboniferous group—has undoubtedly been continued into the Permian period: a well-marked species occurs in the bituminous Mergerl-schiefer of Ruppersdorf, in Silesia: Brongniart notices two species as occurring in Russia; and a specimen of the genus has also been found in the subordinate sandstone at Westoe, in Durham. Calamites are somewhat common; three species having been found in the Todteliegende, near Oschatz; one, in the corresponding rock at Westoe;[1] and four more in Russia. Ferns are more numerous: Professor Naumann has discovered several species near Oschatz; Major Gutbier, and others, have noticed many more found in Saxony. Fischer de Waldheim, Morris, and Brongniart, have made out nineteen species occurring in Perm: beautiful specimens of several others occur in Silesia; and a single one (*Neuropteris Huttoniania*) characterises the Marl slate of Durham: but, on the whole, only a generic relation can be established between them and the numerous Ferns which vegetated during the Carboniferous epoch,—*Neuropteris tenuifolia* found in the mines of Santagulova being the only one as yet identified with a Coal-measure species.[2] *Psaronius*, and some other genera of the sub-class *Filicales*, found

[1] Professor Sedgwick notices "traces of calamites" occurring in the lower New Red Sandstone of Cumberland. (Vide Proceedings Geol. Soc., vol. i, p. 344.)

[2] Carboniferous species of plants have been found in the (?) Triassic beds of Savoy. (Vide postea, p. xvi.)

in the doubtfully periodised Freestones of Chemnitz, may simply be noticed in the present place. The asserted existence of *Sigillaria* in the subordinate sandstone beds of Westoe is of the same value as the supposed occurrence of this genus in the Permian deposits of Russia (vide Brongniart, in 'Geol. Rus.,' vol. ii, p. 11). Of Conifers, it is uncertain whether any have yet been found, the Permian age of which is settled; but from the abundance of coniferous wood in the Carboniferous deposits, it may be confidently expected, that their remains will yet be discovered. The so-called *Cupressites*, and some other Conifer-like plants, occurring in the Mergerl-schiefer of Germany, may perhaps be sea-weeds.

The remains of the animal kingdom occurring in the Permian rocks being tolerably well known, compared with the vegetable Fossils, a better means seems to offer itself for enabling us to arrive at a more positive conclusion in the present inquiry.

Passing over the Sponges, which for many reasons cannot be satisfactorily compared with those of other systems, and the doubtfully related *Foraminifera*, which have been treated so fully by Mr. T. Rupert Jones, as to render any further notice of them supererogatory, we arrive at the Class *Polyparia*—an extensive group of *Radiata*—which flourished abundantly during the Protozoic period. The Permian rocks are singularly deficient in the lamelliferous forms of this class; as only two species have been found, one of which occurs both in England and Germany. The more elevated forms, the Ciliobrachiata, however, are tolerably abundant, some of which, it is suspected, will hereafter be found to be specifically identical with Carboniferous species. The genera *Fenestella*, *Acanthocladia*, and *Phyllopora*, which had representatives in the earlier ages, possessed Permian species rather widely distributed; as the same forms occur in both the German and English rocks: but the genus *Synocladia*, which is not known to have existed in earlier ages, had its species (*Synocladia virgularia*), confined to the Permian rocks of the North of England. It is to be regretted, that we are almost entirely in ignorance respecting the Polyparian fauna of the Triassic system.

The Class *Echinodermata* is very scantily represented in the Permian rocks hitherto examined: only two species, each of which belongs to the two orders, *Crinodeæ* and *Echinideæ*, are all that are known; and both occur in Germany and England. Should the fossil herein named *Archæocidaris Verneuiliana* really belong to the genus in which it is placed, it will serve as an important Echinodermian link by which to connect the Permian with the Carboniferous period: the same may be said, but with more confidence, of *Cyathocrinus ramosus*.

The great division *Articulata* has a few Permian representatives among the *Annellata* and *Crustacea*. The former, from their paucity, are not of much importance in our present consideration; but the latter require more than a passing notice. Considering the abundance of Trilobites in all other Protozoic deposits, it is surprising that none have yet been found in those under consideration: their absence eminently distinguishes the

Permian from the Carboniferous rocks, as a system; while the occurrence of the so-called *Limulus oculatus* in the cupreous grits of Perm, and of such interesting forms as *Limulus anthrax*, *L. rotundatus*, and other probably congeneric species, in the coal field of Coal-brook Dale,[1] links the two systems in close proximity to each other. The Entomostracous Crustaceans have evidently abounded during the Permian epoch; as not only the Pelagic deposit (the Shell-limestone), but the apparently littoral or shallow-water member (the crystalline) contain them, especially the latter, in profusion. Mr. T. Rupert Jones has ascertained that some of these minute organisms are identical with Carboniferous species. Probably some of them will be found in the Permian rocks of Germany; as Professor Naumann states, that the Mergerl-schiefer near Oschatz is loaded with *Cypris:* this reminds me of their prodigious abundance in the limestone near Byers's Quarry, where they give the surface of the slabs quite a granulated aspect. A species of *Cythere* occurs in one of my specimens of fossiliferous limestone collected at Könitz.

Mollusca.—Commencing with the lowest class of this extensive sub-kingdom, it may be stated, that the Permian epoch was rather copiously provided with palliobranchiate forms. Twenty-three species belonging to ten genera are recorded in the present work, to which may be added about fourteen more species, which have been found in Russia. Germany and England have been represented by nearly the same palliobranchiate fauna during the Permian epoch; as most of the species, (*Productus Leplayi*, and one or two more being the exceptions,) have been found in both countries. Some species, as *Trigonotreta alata*, *Camarophoria Schlotheimi*, *Epithyris elongata*, *E. sufflata*, *Cleiothyris pectinifera*, have had their geographical range extended to the North-eastern regions of European Russia, where they are associated with species hitherto unnoticed in England and Germany; namely, *Chonetes sarcinulata*, *Strophalosia Cancrini*, *S. horrescens*, *S. Wangenheimi*, and an un-named species of *Orthis* collected by Count Keyserling in Petschora-land. The genus *Strophalosia*, which is well represented in the Permian rocks of Germany and England, is also very characteristic of those in Russia; but it would appear, that none of the species abundant in the former countries have yet been met with in the latter one: there is, however, a striking similarity between their respective species; for example, *Strophalosia Morrisiana*, and *S. Cancrini*,—*Strophalosia Wangenheimi*, and *S. Goldfussi*. Of the family *Strophomenidæ*, the Permian system appears to possess but one form, *Chonetes sarcinulata* (vide 'Geol. Russ.,' vol. ii, p. 244), belonging to earlier rocks: this one, however, is of considerable importance; inasmuch as its occurring in all the divisions of the Protozoic period, inseparably connects the Permian system with the earliest division of organic time. The singular genus *Streptorhynchus*, which does not appear to reach further back than the Carboniferous period, was represented during the Permian by a single species

[1] The Coal-brook Dale Xiphosurians in the collection of Mr. J. Prestwich will afford a rich treat to the Palæocrustaceologist.

found both in Germany and England, and apparently closely allied to the so-called *Spirifer spurius*, Münster, of the Triassic marls of St. Kassian. Concluding from the apparent absence of congeneric species in more recent rocks, it might be concluded, that the Permian epoch was the last to witness the existence of the genera *Camarophoria*, *Cleiothyris*, and *Strophalosia*. The group *Trigonotreta*, whether we view it as divisible into two great sections depending on histological differences, connects the Permian system both with an earlier and a more recent period: the Triassic *Trigonotreta fragilis*, Goldf., resembles in many respects *T. Permiana*, which, in its turn, has a striking resemblance to a carboniferous species: *Trigonotreta cristata* is closely related to, if not identical with, the carboniferous *T. octoplicata;* and it is also apparently nearly allied to a Jurassic species found at Illminster, and in Wurtemberg. *Cleiothyris pectinifera* has a few proximately related species occurring in the carboniferous rocks; such as *C. expansa*, *C. fimbriata*, *C. oblonga*, and *C. Roissyi*. The genus *Camarophoria*, as far as is known, only conducts us to an earlier age—the carboniferous, which has yielded species (*Camarophoria crumena*, *C. superstes*) closely allied to one thoroughly characteristic of the Permian system, both in its vertical and its horizontal extent,—*Camarophoria Schlotheimi*, it will be remembered, having been found in the Mergerl-schiefer, Zechstein, and Zechstein-dolomit of Germany, as well as in certain of the Permian rocks in the North of England, and on the western flank of the Ural mountains. *Camarophoria multiplicata*, hitherto only found in the fossiliferous limestone of the North of England, appears to have been a local species. *Hypothyris*, so abundant in the Protozoic, and Deuterozoic formations, is suspected to have been represented during the Permian period; but hitherto not a species has yet been discovered in rocks of this age, unless it be the so-called *Terebratula Geinitziana* found by De Verneuil in Russia. The two species of *Epithyris* have undoubtedly lived in the carboniferous epoch; and apparently one of them (*E. sufflata*) either had its existence prolonged into, or was proximately represented during, the Triassic period. The genus *Productus*, were it not for the occurrence of two or more species in the Triassic marls of St. Kassian, might be said to have ceased to exist at the close of the Protozoic period: *Productus horridus*, so characteristic of the Permian rocks, was probably also a carboniferous species; since, besides its apparently occurring in the Mountain Limestone of Lough Macnean, Fermanagh, there is yet to be proved the exact age of the Derbyshire Magnesian Limestone which yields it. The single Permian *Discina speluncaria*, in being found in the Marl-slate, compact limestone, and fossiliferous limestone, has had a tolerably extensive range in time. The same may be said of *Lingula Credneri*, which occurs in the Zechstein of Germany, and the Marl-slate of Durham: it appears to have been also found in the subordinate bed of freestone near Ferry-Hill.

Passing to the Permian Lamellibranchs, some species have had a wide geographical range; for example, *Pleurophorus costatus*, *Allorisma elegans*, *Mytilus septifer*, *Bysso-arca Kingiana*, *Monotis speluncaria*, *Bakevellia antiqua*, and *Solemya biarmica*, which are found

in England, Germany, and Russia; while others appear to have been more local in their habitat, as *Schizodus truncatus*, *S. obscurus*, *Edmondia Murchisoniana*, and *Cardiomorpha modioliformis*—English species; *Cardiomorpha Pallasi*, and *Monotis Kazanensis*—Russian species. Some of the above are limited in their vertical range; while a few, such as *Pleurophorus costatus*, &c., adding *Leda Vinti*, characterise the three highest members. And it is remarkable, that those species which are suspected to have carboniferous representatives, are such as have the most extensive chronological and geographical range: for example, *Solemya biarmica*, which occurs nearly wherever the Permian system is developed, is found in the Kupfer-schiefer of Ilmenau, and in the fossiliferous limestone of Durham; and *Pleurophorus costatus*, equally as extensively distributed geographically, has probably been found in the lowest Permian member, that is, in a bed of limestone between the Weissliegende and Kupfer-schiefer, and in the highest beds of the system—the Marls near Manchester. Some genera, which are extremely abundant in later periods, seem to have commenced their existence during the Permian epoch: the Russian *Ostrea matercula*, De Verneuil, the most anciently known species of the genus, is exceedingly interesting on this account.

The Gasteropods of the Permian period are not quite so numerous as the last class; and the principal point of interest connected with them is in *Chiton Loftusianus*, hitherto only found in England. This species constitutes an important member, by which the great *hiatus* between the Palæozoic and existing species of the genus is becoming gradually filled up. One remarkable circumstance connected with the Permian Gasteropods is their general diminutiveness, which, coupled with their scarcity, seems to indicate that the conditions of the Permian ocean were not altogether favorable for them. The genera *Macrocheilus* and *Pleurotomaria*, which had some splendid and noble representatives during the earlier periods, became impoverished, as it were, in the Permian: and it would appear, from the size of the so-called Turbos and Rissoas found in the Manchester Marls, that species became more and more dwarfed as this period approached its termination. *Pleurotomaria nodulosa* seems to be limited to England, and *P. penea*, to Russia. The genus *Murchisonia*, represented by *M. subangulata* in the Permian rocks only of Russia and Germany, would appear to have occurred for the last time during this period.

Nothing higher than the Tetrabranchiate section of the Cephalopods has yet been found in Permian strata; though, from the presence of Cuttle-fish mandibles (*Rhyncholithes*), and some other co-ordinate remains, in deposits of the Triassic system—perhaps the earliest in which anything of the kind has yet been found—we ought to be prepared for the occurrence of the Dibranchiate section. Considering the abundance of *Goniatites* in the Carboniferous rocks, and the presence of the remarkable genus *Ceratites* in the Triassic system, it is singular that no remains of the family *Ammonitidæ* have yet been found in the Permian deposits, especially, considering that the genera named are completely graduated into each other by means of the transitional group

represented by the Kartinsk *Goniatites Orbignyanus* and *G. Kingianus*. Both genera occur in the (?) Triassic Marls of St. Kassian; so that there is little doubt they will yet be found in strata of the Permian period. The family *Nautilidæ* has only two or three generic representatives in the present rocks. The two species of *Nautilus* are interesting, as having a striking resemblance to the Carboniferous *Nautilus clitellarius* and *N. concavus*. One of the Permian species, *N. Schlotheimi*, is found both in England and Germany; but *N. Bowerbankianus* has only yet been found in the former country. Dr. Geinitz has figured in the 'Versteinerungen' a so-called *Orthoceratites*, said to have been found in the Kupfer-schiefer of Ilmenau,—a statement which may be received with very little doubt, if it be correct, that a congeneric species (*Orthoceros Freieslebeni*) occurs in the Triassic Marls of St. Kassian. M. de Verneuil has found a portion of a *Cyrtoceros* in the limestone (Permian) of Schidrova near Ustvaga.[1]

Fishes appear to have been tolerably abundant in the Permian Ocean: they belong exclusively to the Placoid and Goniolepidot orders—great groups, which, during the Protozoic period were the sole representatives of their class. The order *Placoidei* is scarce in our home deposits,—*Gyracanthus formosus* being the only example found in England, and *Gyropristis obliquus* the only one found in Ireland; five or six, however, have been determined by Count Münster to characterise the Mergerl-schiefer of Riechelsdorf. The order *Goniolepidoti* is better represented. Fishes appear to have been decidedly more local in their habitats than any of the other Permian classes noticed; for it is doubtful if any of the species occurring in Germany have yet been found in England. It requires to be observed, however, that Dr. Geinitz has recorded the occurrence of the English species *Palæoniscus elegans*, *P. glaphyrus*, and *P. macropthalmus*, in the German Kupfer-schiefer: *Palæoniscus Freieslebeni*—a German Permian species, is stated to have been found in the Carboniferous rocks of Ardwick in Lancashire; and M. de Verneuil records the occurrence in Russia of the German species *Palæoniscus lepidurus*, and *P. Vratislaviensis*: but these instances require a further investigation. None of the genera of fishes, with the exception of Münster's Placoids, found in the Permian system, can be strictly said to be essentially characteristic of it; as *Pygopterus*, *Palæoniscus*, *Cœlacanthus*, and *Platysomus*, also characterise (and perhaps to the same extent) the Carboniferous system. While the genus *Palæoniscus* takes us into the Protozoic system, *Platysomus*, by its relation to *Pycnodus*, carries us imperceptibly into the Deuterozoic: this fact, as will hereafter be seen, has an important bearing on the question under consideration.

Class *Reptilia*. Until the important discovery within the last two or three years of *Archigosaurus Decheni*, in the Coal-measures of Saarbruck, the Permian period was considered to have been the first that witnessed the creation of air-breathing animals. However much such a discovery may have diminished the interest attached to the reptilian

[1] Vide Note sur les Équivalents du Système Permien en Europe, p. 12.

fauna of the period in question, the character of this fauna is, nevertheless, such as to command the liveliest attention of all who study the past progress of organic development on our Planet; since, whatever may be our views as to the genesis of species, the structure of the Permian reptiles is confessedly of a higher grade than ought to have been expected. Passing over the doubtful, or imperfectly known genera *Rhopalodon*, *Brithopus*, *Orthopus*, and *Syodon*, discovered in the Permian rocks of Russia, our attention may be directed to the true Reptilians known under the names of *Thecodontosaurus*, *Palæosaurus*, and *Protorosaurus*. These three genera have been placed in the Thecodont (an extinct) section of the order *Lacertilia*; instead of being organized after the type of the most fish-like Perreni-branchiate Batrachians or lowest reptiles, their structure would rank them at the head of the Lacertian order; as they had well organized extremities, and were furnished with teeth implanted in distinct sockets, instead of being soldered, as in frogs, to a simple alveolar parapet.[1] The English and German Thecodont Lacertians are found in the lowest members of the Permian system,—the *Protorosaurus* and *Palæosaurus* having been discovered in the Kupfer-schiefer of Thuringia, and the *Thecodontosaurus*, at Redland near Bristol, in the Magnesian Conglomerate, supposed by many to be the equivalent of the last formation, if not of the subordinate Todteliegende of Germany. The reptiles of the Permian rocks of Russia have been found in the cupreous grits, which are supposed to occupy the highest position in the system. This class of animals is the highest yet known to have lived during the Permian period.

Let us, in the next place, endeavour to ascertain—to what extent its flora and fauna relate the Permian period to that which immediately preceded, or to the one which immediately followed it. But before commencing, it will be necessary to observe, that considering the absence of the remains of many plants and animals, the existence of which during the Triassic period is strongly countenanced by hypothetical considerations,—and, considering the unsettled position of many beds, some of which have been referred to the Carboniferous, and others, to the Triassic system,—it must be evident, that much remains to be done before any very decided view can be taken on the present important question. The conclusion likely to be adopted, however, may, I think, be considered as being approximately correct.

In addition to the few instances already noticed, the presence of Carboniferous species of plants (*Odontopteris Brardii*, *Annularia longifolia*, *Lepidodendron ornatissima*, *Pecopteris Cyathea*, *&c.*)[2] in what appear to be Triassic, or, according to many, Jurassic deposits, near Petit Cœur in the Tarentaise, and other parts of the Alps, where they are associated with Ammonites and Belemnites, shows that several Protozoic forms were continued into the Deuterozoic period. Doubtless a few large groups, and

[1] Owen, 'Report on British Fossil Reptiles,' in Report of the Eleventh Meeting of the British Association, pp. 197-198.

[2] Consult a valuable memoir 'On the Fossil Plants from the Arthracite Formation of the Alps of Savoy,' in the Quarterly Journal of the Geological Society, vol. v, part i, by C. J. F. Bunbury, Esq., F.G.S.

several genera appeared for the first time during the early part of this period; but there is nothing to indicate any great phytological break between the two widely-separated systems—the Carboniferous and Triassic. If it be correct, as stated, that Cycadeous Gymnosperms occur in the Coal-measures of Bohemia, and a species of *Tæniopteris* (*T. Eckhardti*) in the Mansfeld Kupfer-schiefer, it will follow, that the Deuterozoic period is not so much distinguished from the Protozoic by any peculiarity of its great phytological groups. Generically these periods are related to each other: they are also, to a certain extent, specifically connected: it may, therefore, be fairly concluded, that the Permian Flora did not differ to any material extent from either the Carboniferous, or the Triassic.

Of the animal sub-kingdom *Radiata*, little can be predicated. The Polyparians of the Triassic rocks are confessedly too little known to be referred to. The Echinoderms are in the same category. *Cyathocrinus ramosus*, *Archæocidaris Verneuiliana*, and the Corals, however, give the Permian Radiata a Carboniferous aspect.

Referring to the class *Crustacea*, the abundance of Trilobites in the Carboniferous rocks forms a striking contrast to their marked absence in the Permian, and all subsequent formations: in this point of view, the Permian system possesses a negative deuterozoic aspect; while Kutorga's *Limulus oculatus* gives it a positive secondary organic facies: the connexion, however, between the Permian, and Carboniferous systems is still maintained by means of the Coal-brook Dale Xiphosurians.

The Molluscous sub-kingdom binds together the Carboniferous, Permian, and Triassic systems. Several species of the Carboniferous period continued to live, or were closely represented, in the Permian; and a few appear to have had their existence prolonged into the Triassic. There is a strong generic and a faint specific relation running through the three systems; but taking all the classes into consideration, especially the Palliobranchiate, the relation has obviously more of a Protozoic than a Deuterozoic character.

As already observed, it is doubtful whether any of the Permian fishes have been found in the Carboniferous rocks: apparently, then, the Permian system is specifically distinct from the Carboniferous in its Ichthyan relations: generically they are connected with each other; and in this respect the connexion is a very close one. This cannot be so confidently asserted of the Permian, and Triassic systems; though the occurrence of heterocercal Goniolepidots in the Trias rocks near Coburg,—Sir Phillip Egerton's fortunate discovery of the Pycnodont characters of *Platysomus*,—and the presence of the homocerque *Tetragonolepis Murchisoni* in the Permian rocks of Russia,—approximate the fishes of the two systems more closely than was admitted a few years since.

We cannot as yet form any satisfactory conclusion—as to whether the Permian system is more related to the Carboniferous than to the Triassic, in its reptilian fauna. The occurrence of Labyrinthodons and Rhynchosaurs in the Triassic rocks, and, according to

the determination of Von Meyer, of Labyrinthodont forms (*Archigosaurus* and *Sclerocephalus*) in the Coal-measures of Germany, shows that there is a strong reptilian connexion between the Carboniferous, and Triassic systems.[1] The Thecodonts of the Kupfer-schiefer, and Magnesian Conglomerate, certainly do not link together the Reptiles of the Carboniferous and Triassic systems; but, on hypothetical grounds, we are warranted in anticipating, that future researches will establish a more intimate reptilian connexion than at present prevails between these systems, and the one intermediate to them—the Permian.

Considering the foregoing premises, it may, I think, be safely concluded, that the Permian system is, by its Flora and Fauna, united both to the Carboniferous, and Triassic systems;—strongly so in generic respects; but more to the former than to the latter: there is also a specific connexion between them; but it is slighter than the generic; and it is strongest between the Permian, and Carboniferous systems.

These conclusions are quite in accordance with the view taken by Sir Roderick I. Murchison of the value and position of the Permian deposits;—that is, in considering them as a separate group co-ordinate with, and intermediate to, the Carboniferous and Triassic systems,—and including them in the Protozoic, rather than in the Deuterozoic period.

The present subject may be concluded by drawing the reader's attention to the annexed Tables, which show the geographical and geological distribution of the plants and animals known to belong to the Permian system.

[1] Foot impressions of supposed Labyrinthodonts have been observed in the Devonian rocks of the United States by M. Conrad.

[No. I.]

LIST OF FOSSILS

BELONGING TO THE PERMIAN SYSTEM OF ENGLAND AND IRELAND.

+ signifies present. — signifies not present.

The divisions of the Permian system *a, b, c, d, e, f*, refer to the Counties of Northumberland and Durham.

No.	NAMES OF SPECIES.	Freestone (*a*).	Marl-slate (*b*).	Compact limestone (*c*).	Fossiliferous limestone (*d*).	Breccia (*e*).	Crystalline limestone (*f*).	Species occurring in Germany.	Species occurring in Russsia.	Species peculiar to England, or Ireland.
	PLANTS.									
1	Chondrus (?) Binneyi, *King*[1]	—	—	—	—	—	—	—	—	+
2	Polysiphonia (?) Sternbergiana, *King* . . .	—	+	—	—	—	—	—	—	+
3	Caulerpa (?) selagenoides, *Sternberg*	—	+	—	—	—	—	+	—	
4	Neuropteris Huttoniana, *King*	—	+	—	—	—	—	—	—	+
5	Lepidodendron[2]	+	—	—	—	—	—	—	—	+
6	Calamites[3]	+	—	—	—	—	—	—	—	+
7	Sigillaria[4]	+	—	—	—	—	—	—	—	+
	ANIMALS.									
	Spongia.									
8	Scyphia tuberculata, *King*	—	—	—	+	—	—	—	—	+
9	Mammillopora mammillaris, *King*	—	—	—	+	—	—	—	—	+
10	Tragos Tunstallensis, *King*	—	—	—	+	—	—	—	—	+
11	— Binneyi, *King*[5]	—	—	—	—	—	—	—	—	+
12	Bothroconis plana, *King*	—	—	—	+	—	—	—	—	+
	Foraminifera.									
13	Dentalina Permiana, *Jones*	—	—	—	—	—	+	—	—	+
14	— Kingii, *Jones*	—	—	—	—	—	+	—	—	+
15	— (?), *Jones*	—	—	—	—	—	+	—	—	+
16	Textularia triticum, *Jones*	—	—	—	—	—	+	—	—	+
17	— cuneiformis, *Jones*	—	—	—	—	—	+	—	—	+
18	Spirillina, *Jones*	—	—	—	+	—	—	—	—	+

[1] Probably belonging to the highest Permian deposits.
[2] Species not determined.
[3] Idem.
[4] Species not determined.
[5] Probably belonging to the highest Permian deposits.

No.	NAMES OF SPECIES.	Freestone (*a*).	Marl-slate (*b*).	Compact limestone (*c*).	Fossiliferous limestone (*d*).	Breccia (*e*).	Crystalline limestone (*f*).	Species occurring in Germany.	Species occurring in Russia.	Species peculiar to England, or Ireland.
	Polyparia.									
19	Calophyllum Donatianum, *King*	—	—	—	+	—	—	—	—	+
20	Petraia profunda, *Germar*	—	—	—	+	—	—	+	—	
21	Calamopora Mackrothii, *Geinitz*	—	—	+	+	—	—	+	—	
22	Stenopora columnaris, *Schlotheim*	—	—	+	+	—	—	+	—	
23	Alveolites Buchiana, *King*	—	—	—	+	—	—	—	—	+
24	Aulopora Voigtiana, *King*	—	—	—	+	—	—	—	—	+
25	Fenestella retiformis, *Schlotheim*[1]	—	—	—	+	+	—	+	?+	
26	Synocladia virgulacea, *Phillips*	—	—	+	+	+	—	—	—	+
27	Phyllopora Ehrenbergi, *Geinitz*	—	—	—	+	—	—	+	—	
28	Thamniscus dubius, *Schlotheim*	—	—	—	+	—	—	+	—	
29	Acanthocladia anceps, *Schlotheim*	—	—	+	+	+	—	+	—	
	Echinodermata.									
30	Cyathocrinus ramosus, *Schlotheim*	—	—	—	+	+	—	+	—	
31	Archæocidaris Verneuiliana, *King*	—	—	—	+	—	—	+	—	
	Annellata.									
32	Spirorbis helix, *King*	—	—	—	+	+	—	—	—	+
33	— Permianus, *King*	—	—	—	—	—	+	—	—	+
34	Filograna Permiana, *King*	—	—	—	—	—	+	—	—	+
35	Vermilia obscura, *King*	—	—	—	+	—	—	—	—	+
36	Serpula (?) pusilla, *Geinitz*	—	—	—	+	—	—	+	—	
	Crustacea.									
37	Cythere Morrisiana, *Jones*	—	—	—	+	—	—	—	—	+
38	— Geinitziana, *Jones*	—	—	—	+	—	—	—	—	+
39	— elongata, *Münster*[2]	—	—	—	?+	—	—	—	—	+
40	— Kutorgiana, *Jones*	—	—	—	—	—	+	—	—	+
41	— (Bairdia) curta, *M'Coy*[3]	—	—	—	+	—	+	—	—	+
42	— (—) gracilis, *M'Coy*[4]	—	—	—	—	—	+	—	—	+
43	— (— ?) acuta, *Jones*	—	—	—	—	—	+	—	—	+
44	— (Cythereis?) biplicata, *Jones*	—	—	—	—	—	+	—	—	+
45	— (Cytherella ?) inornata, *M'Coy*[5]	—	—	—	—	—	+	—	—	+
46	— (— ?) nuciformis, *Jones*	—	—	—	—	—	+	—	—	+
47	Dithyrocaris Permiana, *Jones*	—	—	—	—	—	+	—	—	+
48	— glypta, *Jones*	—	—	—	—	—	+	—	—	+

[1] Vide *Polypora infundibuliformis*, in next Table.

[2] A Carboniferous species. The specimen noticed was extracted from the Dogger-bank fragment.

[3] A Carboniferous species.

[4] Idem.

[5] Idem.

No.	NAMES OF SPECIES.	Freestone (*a*).	Marl-slate (*b*).	Compact limestone (*c*).	Fossiliferous limestone (*d*).	Breccia (*e*).	Crystalline limestone (*f*).	Species occurring in Germany.	Species occurring in Russia.	Species peculiar to England, or Ireland.
	Palliobranchiata.									
49	Lingula Credneri, *Geinitz*	?+	+	—	—	—	—	+	—	
50	Discina speluncaria, *Schlotheim*	—	+	+	+	—	—	+	—	
51	Productus horridus, *J. Sowerby*	—	—	+	+	+	—	+	—	
52	— umbonillatus, *King*	—	—	—	+	—	—	—	—	+
53	Strophalosia Goldfussi, *Münster*	—	—	—	+	+	—	+	—	
54	— excavata, *Geinitz*	—	—	—	+	—	—	+	—	
55	— Morrisiana, *King*	—	—	+	+	—	—	+	—	
56	— parva, *King*	—	—	—	+	—	—	—	—	+
57	Streptorhynchus pelargonatus, *Schlotheim*	—	—	—	+	+	—	+	—	
58	Camarophoria Schlotheimi, *Von Buch*	—	—	—	+	+	—	+	+	
59	— globulina, *Phillips*	—	—	—	+	+	—	—	—	+
60	— multiplicata, *King*	—	—	—	+	—	—	—	—	+
61	Trigonotreta cristata, *Schlotheim*	—	—	—	+	+	—	+	—	—
62	— multiplicata, *J. de C. Sowerby*	—	—	—	+	—	—	—	—	+
63	— Jonesiana, *King*	—	—	—	+	—	—	—	—	+
64	— alata, *Schlotheim*	—	—	+	+	—	—	+	—	
65	— undulata, *J. de C. Sowerby*	—	—	+	+	+	—	—	?+	
66	— Permiana, *King*	—	—	—	+	—	—	—	—	+
67	Martinia Clannyana, *King*	—	—	—	+	—	—	—	—	+
68	— Winchiana, *King*	—	—	+	—	—	—	—	—	+
69	Cleiothyris pectinifera, *J. de C. Sowerby*	—	—	—	+	+	—	+	+	
70	Epithyris elongata, *Schlotheim*	—	—	—	+	+	—	+	+	
71	— sufflata, *Schlotheim*	—	—	—	+	+	—	+	+	
	Lamellibranchiata.									
72	Pecten pusillus, *Schlotheim*	—	—	+	+	+	—	+	—	
73	Lima Permiana, *King*	—	—	—	+	—	—	—	—	+
74	Monotis speluncaria, *Schlotheim*	—	—	—	+	+	—	+	?+	
75	— radialis, *Phillips*	—	—	—	+	—	—	—	—	+
76	— Garforthensis, *King*[1]	—	—	—	—	—	—	—	—	+
77	Mytilus squamosus, *J. de C. Sowerby*[2]	—	—	—	+	—	—	+	—	
78	— septifer, *King*[3]	—	—	—	?+	—	+	?+	?+	
79	Edmondia Murchisoniana, *King*	—	—	—	+	—	—	—	—	+
80	Bakevellia ceratophaga, *Schlotheim*	—	—	—	+	+	—	+	—	
81	— antiqua, *Münster*[4]	—	—	—	+	+	—	+	+	
82	— tumida, *King*	—	—	—	+	—	—	—	—	+
83	— bicarinata, *King*	—	—	—	+	—	—	—	—	+

[1] Probably belonging to the highest Permian deposits.

[2] In Yorkshire, this species probably occurs in the highest Permian deposits.

[3] Vide postea, pp. 160, 161, 162.

[4] In the Midland districts of England, this species probably occurs in the highest Permian deposits.

No.	NAMES OF SPECIES.	Freestone (*a*).	Marl-slate (*b*).	Compact limestone (*c*).	Fossiliferous limestone (*d*).	Breccia (*e*).	Crystalline limestone (*f*).	Species occurring in Germany.	Species occurring in Russia.	Species peculiar to England, or Ireland.
84	Bakevellia Sedgwickiana, *King*	—	—	—	+	—	—	—	—	+
85	Byssoarca striata, *Schlotheim*	—	—	—	+	—	—	+	—	
86	— tumida, *J. de C. Sowerby*	—	—	—	+	—	—	—	—	+
87	— Kingiana, *De Verneuil*	—	—	—	+	—	—	+	+	
88	Nucula Tateiana, *King*	—	—	—	+	—	—	—	—	+
89	Leda Vinti, *King*	—	—	+	+	—	+	+	—	
90	Solemya biarmica, *De Verneuil*	—	—	—	+	—	—	+	+	
91	— Phillipsiana, *King*	—	—	—	+	—	—	—	—	+
92	Cardiomorpha modioliformis, *King*	—	—	—	+	—	—	—	—	+
93	Pleurophorus costatus, *Brown*[1]	—	—	+	+	+	+	+	?+	
94	Schizodus obscurus, *J. Sowerby*[2]	—	—	—	—	—	—	—	—	+
95	— rotundatus, *Brown*	—	—	—	—	—	—	?+	—	
96	— Schlotheimi, *Geinitz*	—	—	—	—	—	+	+	—	
97	— truncatus, *King*	—	—	+	+	—	—	—	—	+
98	Astarte Vallisneriana, *King*	—	—	+	—	—	—	—	—	+
99	— Tunstallensis, *King*	—	—	—	+	—	—	—	—	+
100	Allorisma elegans, *King*	—	—	+	+	—	—	+	?+	
101	Psammobia (?) subpapyracea, *King*	—	—	—	+	—	—	—	—	+
	Gasteropoda.									
102	Chiton Loftusianus, *King*	—	—	—	+	—	—	—	—	+
103	Turbo helicinus, *Schlotheim*[3]	—	—	—	+	—	—	+	—	
104	— Mancuniensis, *Brown*[4]		—	—	+	?+	—	—	—	+
105	— Permianus, *King*	—	—	—	+	—	+	—	—	+
106	— Thomsonianus, *King*	—	—	—	+	?+	—	—	—	+
107	— Taylorianus, *King*	—	—	—	+	—	—	—	—	+
108	Rissoa obtusa, *Brown*[5]	—	—	—	—	—	—	+	—	?+
109	— Leighi, *Brown*[6]	—	—	—	—	—	—	—	—	+
110	— Gibsoni, *Brown*[7]	—	—	—	—	—	—	—	—	+
111	Loxonema fasciata, *King*	—	—	—	+	—	—	—	—	+
112	— Swedenborgiana, *King*	—	—	—	+	—	—	—	—	+
113	— Geinitziana, *King*	—	—	—	+	—	—	—	—	+
114	Macrocheilus symmetricus, *King*	—	—	—	+	—	—	—	—	+
115	Euomphalus Permianus, *King*	—	—	—	+	—	—	—	—	+
116	Natica minima, *Brown*[8]	—	—	—	—	—	—	—	—	+
117	— Leibnitziana, *King*	—	—	—	+	—	—	+	—	

[1] At Newton, this species probably occurs in the highest Permian deposits.
[2] Probably belonging to the highest Permian deposits.
[3] Besides occurring in the Fossiliferous limestone, it also probably belongs to the highest Permian deposits.
[4] Idem.
[5] Probably belonging to the highest Permian deposits.
[6] Idem.
[7] Idem.
[8] Idem.

No.	NAMES OF SPECIES.	Freestone (*a*).	Marl-slate (*b*).	Compact limestone (*c*).	Fossiliferous limestone (*d*).	Breccia (*e*).	Crystalline limestone (*f*).	Species occurring in Germany.	Species occurring in Russia.	Species peculiar to England, or Ireland.
118	Pleurotomaria antrina, *Schlotheim*	—	—	—	+	+	—	+	—	
119	— Tunstallensis, *King*	—	—	—	+	—	—	—	—	+
120	— nodulosa, *King*	—	—	—	+	—	—	—	—	+
121	— Linkiana, *King*	—	—	—	+	—	—	—	—	+
122	Dentalium Sorbii, *King*[1]	—	—	—	—	—	—	—	—	+
	Cephalopoda.									
123	Nautilus Freieslebeni, *Geinitz*	—	—	+	+	+	—	+	—	
124	— Bowerbankianus, *King*	—	—	—	+	—	—	—	—	+
	Pisces.									
125	Gyracanthus formosus, *Agassiz*[2]	+	—	—	—	—	—	—	—	+
126	Gyropristis obliquus, *Agassiz*[3]	—	—	—	—	—	—	—	—	+
127	Palæoniscus elegans, *Sedgwick*	—	+	—	—	—	—	—	—	+
128	— comtus, *Agassiz*	—	+	—	—	—	—	—	—	+
129	— glaphyrus, *Agassiz*	—	+	—	—	—	—	—	—	+
130	— macropthalmus, *Agassiz*	—	+	—	—	—	—	—	—	+
131	— longissimus, *Agassiz*	—	+	—	—	—	? +	—	—	+
132	— catopterus, *Agassiz*[4]	—	—	—	—	—	—	—	—	+
133	Platysomus macrurus, *Agassiz*	—	+	—	—	—	—	—	—	+
134	— striatus, *Agassiz*	—	+	+	—	—	—	—	—	+
135	Acrolepis Sedgwicki, *Agassiz*	—	+	—	—	—	—	—	—	+
136	Pygopterus mandibularis, *Agassiz*	—	+	—	—	—	—	—	—	+
137	— sculptus, *Agassiz*	—	+	—	—	—	—	—	—	+
138	— latus, *Egerton*	—	+	—	—	—	—	—	—	+
139	Cœlacanthus granulosus, *Agassiz*	—	+	—	—	—	—	—	—	+
140	— caudalis, *Egerton*	—	+	—	—	—	—	—	—	+
	Reptilia.									
141	Palæosaurus cylindrodon, *Riley and Stutchbury*[5]	—	—	—	—	—	—	—	—	+
142	— platyodon, *Riley and Stutchbury*[6]	—	—	—	—	—	—	—	—	+
143	Thecodontosaurus antiquus, *Riley and Stutchbury*[7]	—	—	—	—	—	—	—	—	+

[1] Position in the Permian system not known.
[2] A Carboniferous species.
[3] Probably belonging to the highest Permian deposits.
[4] Probably belonging to the highest Permian deposits.
[5] Exact position in the Permian system unknown.
[6] Idem.
[7] Idem.

[No. II.]

LIST OF PERMIAN FOSSILS

PECULIAR TO GERMANY, OR RUSSIA.

No.	NAMES OF SPECIES.	Species peculiar to Russia.	Species peculiar to Germany.	OBSERVATIONS.
	PLANTS.			
1	Caulerpites brevifolius, *Münster* . .	—	+	
2	— intermedius, *Münster* . .	—	+	
3	— distans, *Münster* . . .	—	+	
4	— spiciformis, *Sternberg* . :	—	+	
5	Zonarites digitatus, *Sternberg* . . .	—	+	
6	Chondrites virgatus, *Münster* . . .	—	+	
7	Walchia, *Naumann*	—	+	Professor Naumann notices one species of *Walchia* or *Lycopodites* occurring in the neighbourhood of Oschatz.
8	Weissites sphericus, *Münster* . . .	—	+	
9	— (?), *Geinitz*	—	+	
10	Tæniopteris Eckhardti, *Germar* . .	—	+	
11	Pecopteris Schwedesiana, *Dunker* . .	—	+	
12	— Martinsi, *Germar* . . .	—	+	
13	— Gœpperti, *Morris* . . .	+	—	
14	— Wangenheimi, *Fischer* . .	+	—	
15	— Grandini, *Fischer* . . .	+	—	
16	— , *Naumann*	—	+	
17	Sphenopteris Gœpperti, *Münster* . .	—	+	
18	— erosa, *Morris* . . .	+	—	Professor Naumann states, that this species, and three or four more, are found in the Permians of Oschatz.
19	— dichotoma, *Althaus* . .	—	+	
20	— incerta, *Fischer* . . .	+	—	
21	— lobata, *Morris* . . .	+	—	
22	— (?) bipinnata, *Münster* . .	—	+	
23	— (?) patens, *Althaus* . . .	—	+	
24	Neuropteris dichotoma (?), *Fischer* . .	+	—	Originals, having a doubtful identification with extra-Permian species.
25	— flexuosa, *Brongniart* . .	+	—	
26	— heterophylla, *Brongniart* .	+	—	
27	— Grangeri, *Brongniart* . .	+	—	
28	— macrophylla, *Brongniart* .	+	—	
29	— rotundifolia, *Brongniart* . .	+	—	
30	— Villiersii, *Brongniart* . .	+	—	
31	— Voltzii, *Brongniart* . .	+	—	
32	— salicifolia, *Fischer* . . .	+	—	
33	— tenuifolia, *Brongniart* . .	+	—	A Carboniferous species.

No.	NAMES OF SPECIES.	Species peculiar to Russia.	Species peculiar to Germany.	OBSERVATIONS.
34	Neuropteris conferta, *Gœppart* . . .	—	+	Professor Naumann notices a species of *Neuropteris* occurring in the Permian rocks of Oschatz. Perhaps it is the same as the one cited, which is found at Ruppersdorf.
35	Odontopteris Fischeri, *Brongniart* . .	+	—	
36	— Permiensis, *Brongniart* .	+	—	
37	— Strogonovi, *Fischer* . .	+	—	
38	— , *Naumann*	—	+	Professor Naumann states, that two species of *Odontopteris* occur in the environs of Oschatz.
39	Nœggerathia cuneifolia, *Kutorga* . .	+	—	
40	— expansa, *Brongniart* . .	+	—	
41	Lepidodendron elongatum, *Brongniart* .	+	—	A Carboniferous species.
42	— ined. sp., *Brongniart* . .	+	—	
43	—	—	+	I have seen beautiful specimens of a Lepidodendron collected at Ruppersdorf; but I am not acquainted with the species.
44	Calamites gigas, *Brongniart* . . .	+	—	A Carboniferous species. Professor Naumann states that this and other two Calamites occur at Oschatz.
45	— Suckowii, *Brongniart* . .	+	—	A Carboniferous species.
46	— arenaceus, *Fischer* . . .	+	—	
47	— trigonus, *Kutorga* . . .	+	—	
48	Cupressites Ullmanni, *Bronn* . . .	—	+	These are probably Fucoids.
49	— bituminosus, *Geinitz* . .	—	+	
50	— frumentarius, *Schlotheim* .	—	+	
51	— pectinatus, *Sternberg* . .	—	+	
52	— , *Geinitz*	—	+	
53	Leaves of Conifer, *Geinitz* . . .	—	+	
	ANIMALS.			
	Polyparia.			
54	Coscinum dubium, *Geinitz* . . .	—	+	
55	Anthophyllum incrustans, *Lonsdale* . .	+	—	
56	Alveolites producti, *Geinitz* . . .	—	+	Suspected to occur in the North of England Permians.
57	Stenopora spinigera, *Lonsdale* . . .	+	—	Idem.
58	— crassa, *Lonsdale* . . .	+	—	
59	Polypora infundibuliformis, *Goldfuss* .	+	—	Count Keyserling records a fossil with this name occurring in Petschoraland. It is the same as the one recorded in the 'Geology of Russia,' under the name of *Fenestella infundibuliformis;* but I suspect it is identical with the *Fenestella retiformis* of Schlotheim.
60	— biarmica, *Keyserling* . . .	+	—	
	Crustacea.			
61	Limulus oculatus, *Kutorga* . . .	+	—	
	Palliobranchiata.			
62	Productus Leplayi, *De Verneuil* . .	+	—	Dr. Geinitz records this species as occurring in Germany.
63	Strophalosia Wangenheimi, *De Verneuil* .	+	—	
64	— horrescens, *De Verneuil* .	+	—	
65	— Cancrini, *De Verneuil* . .	+	—	

No.	NAMES OF SPECIES.	Species peculiar to Russia.	Species peculiar to Germany.	OBSERVATIONS.
66	Chonetes sarcinulata, *Schlotheim*	+	—	A species occurring in all the great divisions of the Protozoic period.
67	Orthis ined. sp., *Keyserling*	+	—	Apparently a Strophomena.
68	Camarophoria superstes, *De Verneuil*	+	—	Dr. Geinitz records these two species as occuring in Germany, which is rather doubtful.
69	Hypothyris (?) Geinitziana, *De Verneuil*	+	—	
70	Trigonotreta curvirostris, *De Verneuil*	+	—	
71	— Blasii, *De Verneuil*	+	—	
72	— rugulatus, *De Verneuil*	+	—	
73	Spirifer (?) Schrenkii, *Keyserling*	+	—	
74	Cleiothyris Roissyi, *L'Eveille*	+	—	M. de Verneuil notices the occurrence of *Athyris concentrica* (*Tereb. id.*), Von Buch, in the Permian rocks of Russia; but this appears to be doubtful.
75	Epithyris Qualenii, *Fischer*	+	—	
	Lamellibranchiata.			
76	Ostrea matercula, *De Verneuil*	+	—	
77	Pecten Kokcharofi, *De Verneuil*	+	—	
78	Monotis Kazanensis, *De Verneuil*	+	—	
79	— sericea, *De Verneuil*	+	—	
80	— lorata, *Keyserling*	+	—	
81	— impressa, *Keyserling*	+	—	
82	Pinna (?) prisca, *Laspe*	—	+	A doubtful fossil,—probably a plant.
83	Leda Kazanensis, *De Verneuil*	+	—	
84	— parunculus, *Keyserling*	+	—	
85	Nucula Wymmensis, *Keyserling*	+	—	
86	Cardiomorpha Pallasi, *De Verneuil*	+	—	
87	— minuta, *Keyserling*	+	—	
88	Schizodus Rossicus, *De Verneuil*	+	—	
89	— , *De Verneuil*	+	—	Vide *Postea*, p. 193.
90	Osteodesma Kutorgiana, *De Verneuil*	+	—	
91	Anthracosia umbonatus, *Fischer*	+	—	
92	— ined. sp., *Kutorga*	+	—	
	Gasteropoda.			
93	Turritella biarmica, *De Verneuil*	+	—	
94	Turbonilla Altenburgensis, *Geinitz*	—	+	
95	Pleurotomaria penea, *De Verneuil*	+	—	
96	— Verneuiliana, *Geinitz*	—	+	
97	Murchisonia subangulata, *De Verneuil*	+	—	Dr. Geinitz records this species as occurring in Germany.
	Cephalopoda.			
98	Cyrtoceros (?), *De Verneuil*	+	—	
99	Orthoceros, *Geinitz*	—	+	

No.	NAMES OF SPECIES.	Species peculiar to Russia.	Species peculiar to Germany.	OBSERVATIONS.
	Pisces.			
100	Janassa bituminosa, *Schlotheim* . . .	—	+	
101	— dictea, *Münster*	—	+	
102	Dictea striata, *Münster*	—	+	
103	Wodnika striatula, *Münster* . . .	—	+	
104	Byzenos latipinnatus, *Münster* . . .	—	+	
105	Radamus macrocephalus, *Münster* . .	—	+	
106	Palæoniscus Freieslebeni, *Agassiz* . .	—	+	
107	— lepidurus, *Agassiz* . . .	—	+	
108	— macropomus, *Agassiz* . .	—	+	
109	— speciosus, *Münster* . .	—	+	
110	— Vratislaviensis, *Agassiz* . .	—	+	
111	— magnus, *Agassiz* . . .	—	+	
112	— ornatus, *Münster* . . .	—	+	
113	— Tcheffkini, *Fischer* . .	+	—	Probably the number of Russian Permian Fossils will be considerably increased hereafter. M. de Verneuil submitted some apparently new species to M. Agassiz; several more are in the Collection of the School of Mines of St. Petersburg; and others, deposited in the Royal Museum of Berlin, have been collected by Rose and Ehrenberg, in the cupreous grits of Verschni Moulinsk, near Perm.
114	Tetragonolepis Murchisoni, *Fischer* . .	+	—	
115	Platysomus gibbosus, *Blainville* . . .	—	+	
116	— rhombus, *Agassiz* . . .	—	+	
117	— intermedius, *Münster* . .	—	+	
118	— Althausi, *Münster* . . .	—	+	
119	— Fuldai, *Münster* . . .	—	+	
120	Globulodus elegans, *Münster* . . .	—	+	A species of *Platysomus*.
121	Dorypterus Hoffmanni, *Germar* . . .	—	+	
122	Acrolepis asper, *Agassiz*	—	+	
123	— exculptus, *Germar* . . .	—	+	
124	— angustus, *Münster* . . .	—	+	
125	— giganteus, *Münster* . . .	—	+	
126	— intermedius, *Münster* . . .	—	+	
127	Pygopterus Humboldti, *Agassiz* . . .	—	+	
128	Cœlacanthus Hassiæ, *Münster* . . .	—	+	
	Reptilia.			
129	Protorosaurus Speneri, *Von Meyer* . .	—	+	
130	Palæosaurus, *Geinitz*	—	+	Vide Versteinerungen, p. 3, pl. i.
131	Rhopalodon Wangenheimi, *Fischer* . .	+	—	
132	Brithopus priscus, *Kutorga* . . .	+	—	"These three species require a further examination." (De Verneuil.)
133	Orthopus primævus, *Kutorga* . . .	+	—	
134	Syodon biarmicum, *Kutorga* . . .	+	—	

[No. III.]

SUMMARY OF PERMIAN FOSSILS.

	Totality of Genera.	Totality of Species.	Species occurring in England and Ireland.	Species peculiar to England, or Ireland	Species peculiar to Russia.	Species peculiar to Germany.
Plants	17	60	7	? 6	27	26
Animals . . .						
Spongia . . .	4	5	5	5	—	—
Foraminifera . .	3	6	6	6	—	—
Polyparia . .	14	18	11	4	5	2
Echinodermata .	2	2	2		—	—
Annellata . .	4	5	5	4	—	—
Crustacea . .	3	13	12	12	1	—
Palliobranchiata .	14	37	23	9	14	—
Lamellibranchiata .	19	47	30	16	16	? 1
Gasteropoda . .	? 10	26	21	? 18	3	2
Cephalopoda . .	3	4	2	1	1	1
Pisces . . .	? 14	? 45	16	? 16	2 (—?) more	27
Reptilia . . .	7	9	3	3	4	2
	114	277	143	100	73	61

There now remains the pleasing duty of acknowledging my obligations to a number of kind friends who have in various ways assisted me in the present work ;— some with the loan, or gift of specimens and books,—others with many valuable and varied communications, or other favours, which they were always ready to oblige me with when solicited. In these respects, my thanks are especially due to Professor D. T. Ansted, M.A., &c., King's College; Rev. G. C. Abbs, Cleadon; Dr. Baird, British Museum; Professor Dr. Bensbach, Queen's College, Galway; Mr. E. W. Binney, Manchester; Mr. T. Bramwell, Enfield House, Gateshead; M. Bouchard-Chantereaux, Boulogne; Mr. Thomas Davidson, Mem. Soc. Géol. de Fr.; Mr. J. E. Gray, F.R.S., &c., British Museum; Dr. Richard Griffith, Dublin; Mr. James Hardy, Berwickshire; Mr. John Jameson, Newcastle-on-Tyne; Mr. J. G. Jeffreys, F.R.S., &c., Swansea;

Professor Dr. L. de Koninck, Liége; Count Alexandre von Keyserling, St. Petersburg; Mr. John Morris, F.G.S., &c.; Sir Roderick Impey Murchison, G.C.S. &c.; Professor James Nicol, Queen's College, Cork; Professor Richard Owen, F.R.S., &c.; Professor John Phillips, F.R.S., &c.; Mr. John Pickering, London; Mr. Joseph Prestwich, jun., F.G.S.; Mr. John Rogerson, Newcastle-on-Tyne; Mr. J. de C. Sowerby, F.L.S., &c.; Mr. J. W. Salter, A.L.S., &c.; Rev. Professor Sedgwick, M.A., &c.; Mr. H. C. Sorby, F.G.S., Woodbourn, near Sheffield; Professor Dr. John Scouler, Dublin Royal Society; Mr. G. Tate, F.G.S., Alnwick; M. Ed. de Verneuil, Paris; Mr. Robert Vint, Sunderland; and Mr. Edward Wood, Richmond, Yorkshire.

I must also express my deep obligations to Sir Philip de Malpas Grey Egerton. Bart., M.P., F.R.S., &c., for his highly valuable contributions on Permian Ichthyology, Had this portion of the present Monograph depended on my own resources and competency, it certainly would have been greatly deficient in one of its most important features: considering this, I feel myself particularly called on, to express how much I feel the compliment of having been assisted by one who so ably represents the great Agassiz among British Palæontologists. While on this subject, I feel it my duty to express my thanks to the Council of the Yorkshire Philosophical Society, and the Curator of the Museum, Mr. E. Charlesworth, F.G.S.; also to Dr. Edward Charlton, and the Committee of the Natural History Society of Northumberland, Durham, and Newcastle-on-Tyne, for the loan of several invaluable specimens of fossil fish, most of which are herein figured; and to Mrs. Surtees, of Mainsforth, for the loan of all the specimens belonging to the valuable collection of her late gifted husband, the author of the 'History and Antiquities of the County Palatine of Durham.'

My obligations are also deservedly due to Mr. T. Rupert Jones, Assistant Secretary, &c., of the Geological Society of London, for his excellent notes on the Permian *Foraminifera* and *Entomostraca*, which, had it not been for his labours, would only have been briefly noticed in the present work.

To the President, Sir Henry de la Beche, F.R.S., &c., and the Council of the Palæontographical Society, and especially to the courteous and indefatigable Honorary Secretary, Mr. J. S. Bowerbank, F.R.S., &c., I am under the deepest obligation,—not only for the many favours they have kindly obliged me with,—but because I feel persuaded the labour they have expended in connexion with this Monograph, has too seriously encroached on time that might have been more profitably occupied on those studies in which they respectively have earned the highest reputation.

WILLIAM KING.

Prospect Hill, Galway,
July, 1850.

CORRIGENDA.

Page 2, line 1, *for* "*Lichinales*," *read* "*Lichenales*."
„ 6, „ 22, *for* "*Marsilaceæ*," *read* "*Marsileaceæ*."
„ 21, „ 7, *for* "like the first," *read* "like that of the first."
„ 22, „ 16, *for* "POLYCÆLIA," *read* "POLYCŒLIA."
„ — „ 23, *for* "*Polycælia*," *read* "*Polycœlia*."
„ 68, „ 7 from bottom, *for* "*Cleiothyris*," *read* "*Athyris*."
„ — bottom line, *for* "*Delthyris*," *read* "*Trigonotreta*."
„ 69, line 6 from bottom, *omit* "(*caput-serpentis*) and in *Gryphus*."
„ — „ — „ *for* "*vitreus*," *read* "*vitrea*."
„ — „ — „ *for* "it is somewhat ring-shaped," *read* "it is short, and somewhat ring-shaped."
„ — „ 4 „ *insert* "long," *after* "attached"
„ — „ 2 „ *for* "*dorsata*," *read* "*truncata*."
„ 70, „ 2 from top, *for* "*Pachyrhynchus roseus*," *read* "*Bouchardia rosea*."
„ — „ 20, „ *omit* "*Delthyris* and."
„ — „ 23, „ *for* "*Delthyris*," *read* "*Trigonotreta*."
„ 72, „ 11 from bottom, *for* "*Roysii*," *read* "*Roissyi*."
„ 75, „ 15 „ *insert* "and" *after* "circumstance."
„ 77, „ 20 from top, *insert* "similar to those," *after* "arteries (*j*)."
„ 81, first line in Table, "Lingula" ought to be in italics.
„ — line 20 „ *for* "Dicælosio," *read* "Dicœlosia."
„ — „ 31 „ *omit* "*Delthyris* (elevata), Dalman."
„ — „ 43 „ *for* "Pectunculus," read "Pectunculoides."
„ 82, „ 4 from top, *for* "SUB-KINGDOM," *read* "SUB-CLASS."
„ 93, last line in foot-note 4, *for* "a character of which," read "a character the existence of which."
„ 94, line 8 from top, *for* "the name of which," *read* "my name for which."
„ — „ 5 from bottom, *for* "same," *read* "small."
„ 95, „ 7 „ *for* "were either free," *read* "that they were either free."
„ — „ 2 „ *for* "prove," *read* "proves."
„ 97, „ 17 from top, *for* "species," *read* "specimens."
„ — „ 19 „ *omit* "to be," *and* "with."
„ 99, „ 8 from top, *for* "constitute," *read* "constitutes."

Page 99, List of localities, *omit* "and Tynemouth."
„ 102, line 2 from top, *insert* "Whitley" *after* "Dalton-le-Dale."
„ 104, foot-note 6, *for* "l" *read* "all."
„ 106, line 24 from top, *for* "*Dicælosia*, *read* "*Dicœlosia*."
„ 128, „ 15 „ *for* "incurving," *read* "incurved."
„ 129, „ 19 „ do. do.
„ 142, „ 7 „ *for* "*pectunculus*," *read* "*pectunculoides*."
„ — „ 11 „ *omit* sentence "It appears to be, &c."
„ 145, „ 18 from top, *for* "crural base," *read* "crural processes."
„ 147, „ 2 „ *for* "is," *read* "appears to be."
„ — „ 29 „ *insert* "*Kutorga*," after "PLICA," and *omit* "Kutorga."
„ 150, „ 15 from bottom, *for* "with," *read* "from."
„ 164, last line in footnote 3, *for* "*Janeia*," *read* "*Solemya*."
„ 177, line 20 from top, *omit* "or tertiary." Mem. *Solemya Mediterranea* occurs in the Tertiary deposits of Italy.
„ — „ 22, *for* "The recent *Solemya*, and the Palæozoic *Janeia* are, &c." *read* "*Solemya* is the only genus, &c."
Pages 178 and 179, *for* "*Janeia*" read "*Solemya*."
Page 178, omit diagnosis of *Janeia*.
„ 212, bottom line, *for* "laminæ," *read* "lines."
„ 213, line 2 from top, *omit* "and distinctly separated from each other."
„ — „ 17, *for* "and still an inhabitant," *read* "and is still an inhabitant."
„ 219, line 17, place the name "*Phillips*" close after "NAUTILUS."
Letterpress to Plate VI, second page, line 1, *for* "Palæchinus," *read* "Archæocidaris." The same correction in line 4.
— Pl. XIV, first page, line 15, *omit* "adductor."
— Pl. XVII, line 7, *insert* "Pleurotomaria antrina," *after* figure "6."
— „ „ 13, *for* "Freieslebeni," *read* "Freiesleben."
— „ „ 25, *insert* "Freieslebeni," *after* figure "20."
— Pl. XXVIII, line 4, *for* "granulosus," *read* "granulatus."

FOSSILS OF THE PERMIAN SYSTEM.

PLANTS.

The Phytological Division of Organic Nature has only a few known representatives in the Permian System of England, and these belong exclusively to the lowest classes.

Sub-kingdom CRYPTOGAMÆ.

Guided by the classification and nomenclature of M. Adolphe Brongniart and Dr. Lindley, it is intended to separate this sub-kingdom into the two large groups or classes, *Thallogenæ* and *Acrogenæ*, as proposed in the latest publications of these writers.[1]

Class Thallogenæ, Lindley.

Cellulares, *De Candolle.*
Les Cryptogames Celluleuses, *Ad. Brongniart.*
Cryptophyta, *Link.*
Thallophyta, *Endlicher.*
Amphigenæ, *Ad. Brongniart.*
Thallogens, *Dr. Lindley.*

Diagnosis.—"Stems and leaves undistinguishable."[2] (Lindley.)

The whole of the plants stationed in this class are remarkable for the extreme simplicity of their structure. They are mere masses of cells, having no wood, properly so called, although in the case of some sea-weeds and funguses, they must acquire considerable age.[3]

[1] Enumération des Genres de Plantes cultivés au Muséum d'Histoire Naturelle de Paris, &c., by M. Adolphe Brongniart, 1843; and The Vegetable Kingdom, by Dr. Lindley, 1847.

[2] The Vegetable Kingdom, p. 5, 1847.

[3] Idem, p. 5, 1847.

Of the three groups or sub-classes (*Algales*, *Fungales*, and *Lichinales*,) into which the Thallogens are divided, the first is the only one of which any remains have been found in the Permian rocks.

Sub-class Algales, Lindley.[1]

Diagnosis.—"Cellular flowerless plants, nourished through their whole surface by the medium in which they vegetate; living in water or very damp places; propagated by zoospores, coloured spores, or tetraspores."[2]

The sea-weeds found in the Permian rocks of England are so imperfectly preserved that it is difficult to define them generically. It is probable that some of them belong to extinct or undefined genera, but until they are better known, it is considered the safest plan to place them in those established generic groups to which they offer the strongest resemblance.

Genus *Chondrus*, Stackhouse.

Diagnosis.—"Frond cartilaginous, dilating upwards into a flat, nerveless, dichotomously divided frond, of a purplish or livid red colour; fructification subspherical capsules in the substance of the frond (rarely supported on little stalks), and containing a mass of minute free seeds."[3]

The type of this genus is the *Fucus crispus* of Linnæus, a species common on every part of the British coasts.

Chondrus (?) Binneyi, *King*. Plate I, fig. 1.

"Little circular bodies, resembling the casts of a very small Ammonite,"
Binney. Trans. Manch. Geol. Soc., vol. i, p. 56, 1839.

The specimen figured is the only one known to the writer. It belongs to a species which appears to have had a somewhat broad frond, with numerous closely-crowded, sessile seed-vessels. In one or two places the seed-vessels are so closely approximated as to have assumed a polygonal form, which shows that they have been of a yielding substance. Mr. Binney, to whom the discovery of this interesting fossil is due, found it in the Red Marl at Newton, near Manchester. The "little circular bodies" noticed above are the capsules alluded to.

[1] Dr. Lindley applies the term "Alliance" to what are in the text named *Sub-classes*.

[2] Lindley, The Vegetable Kingdom, p. 8, 1847.

[3] Greville, Algæ Britannicæ, p. 126, 1830.

Genus *Polysiphonia*, Greville.

Diagnosis.—"Filaments partially or generally articulate, longitudinally striated with internal parallel tubes. Fruit double. 1 ovate capsule furnished with a terminal spore; 2 granules immersed in distorted ramuli."[1]

The inarticulate *Fucus fructiculosus*, Wulf., common on the south coasts of England and Ireland, is the type of this genus.

Polysiphonia (?) Sternbergiana, *King*. Plate I, Fig. 2.

Confervites (?), *King*. Catalogue, p. 5, 1848.

This is a Conferva-like plant, with numerous filiform branches, proceeding from a slender stem.

The only specimen apparently known was found in the Marl-slate of Thickley.

Genus *Caulerpa*, Lamouroux.

Diagnosis.—"Frons viridis, membranacea, plana vel cylindracea, stipitata, surculo repente cartilagineo radicante instructa. Fructus . . . . (?)"[2]

M. Adolphe Brongniart, speaking of the fossil next to be described, and other three species found in the Kupferschiefer of Thuringia, states that "they appear to be related to the genus *Caulerpa*."[3] Perhaps it would not be going too far to suggest that they may belong to the fourth section of the genus characterised as having "ramulis undique imbricatis, linearibus vel setaceis." (?)

Caulerpa (?) selaginoides, *Sternberg*. Plate I, fig. 3.

Caulerpites selaginoides, *Sternberg*. Versuch. p. 20, 1821.
— lycopodoides „ Idem.
Fucoides lycopodoides, *Sternberg*. Brongniart, Vég. Foss. p. 73, pl. 9, fig. 3, 1828.
— selaginoides „ „ Idem, p. 73, pl. 9, fig. 2, 1828.
(?) One of the "Two species of Ferns," cited by *Sedgwick*. Trans. Geol. Soc. Lond. 2d series, vol. iii, p. 120, 1829.
Voltzia Phillipsii, *Lindley* and *Hutton*. Fossil Flora, vol. iii, pl. 195, 1836.
(?) Pinna (?) prisca, *Münster*. Beiträge, p. 45, pl. 4, fig. 4, 1839; and p. 66, pl. 4, fig. 4, 1843.
(?) Solen, *Geinitz*. Grundriss, p. 450, 1846.
Fucoides (Caulerpa ?) lycopodoides, *Brong*. King, Catalogue, p. 5, 1848.
Voltzia, *Howse*. T. F. N. C. vol. i, p. 264, 1848.
(?) Solen (?) pinnæformis, *Geinitz*. Versteinerungen, p. 8, 1848.
Caulerpites selaginoides, *Sternb*. Geinitz, Verst. p. 21, pl. 8, figs. 9, 10, 1848.

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[1] Smith, The English Flora, vol. v, p. 327, 1833.
[2] Greville, Algæ Britannicæ, Synopsis, p. lxiii.
[3] Histoire des Végétaux Fossiles, p. 43, 1828.

Diagnosis.—"F. caule pinnatum ramosa, foliis sparsis numerosis, caulem indique, tegentibus, oblongo-linearibus membranaceis (?) enervis."[1]

After examining a number of specimens, none of which, however, were so instructive as could be desired, the writer feels it necessary to unite the three so-called species *Voltzia Phillipsii*, Lind. and Hutt., *Fucoides selaginoides*, Sternb., and *F. lycopodoides*, Sternb., the differences being so slight, that he is strongly persuaded they represent different parts of the same species.

The form named *Fucoides lycopodoides*, according to M. Ad. Brongniart, strongly resembles those Caulerpas with distichous leaves, as *C. pennata*, Tourn., and *C. taxifolia*, Tourn.: it appears to differ from them simply in the leaves being larger, and less regularly arranged. The specimen of *C. selaginoides* figured in the 'Histoire des Végétaux Fossiles' agrees in many respects with the *C. selago*.

Pinna (?) *prisca*, Münster, appears to be a compressed portion of the stem of *Caulerpa* (?) *selaginoides*. Fragments of a vegetable fossil occasionally occur in the Marl-slate strikingly resembling the figure in Count Münster's 'Beiträge,' and which it is difficult to conceive to be anything else but the remains of the stem of this plant. They are transversely barred, somewhat as in the fossil figured by Count Münster, a character which appears to be due to transverse cracks, resulting from the shrinking up of the (cellular?) substance of which they were composed.

As Professor Sedgwick, in the Supplement to his paper (Trans. Geol. Soc. 2d series, vol. iii, p. 239), doubts "the two vegetable impressions," noticed by him elsewhere (Op. cit. pp. 77, 120), as being "two species of Fern," it is suggested that one of them may have been the fossil under consideration: there can be little doubt, however, that at least one of them was a plant of this kind (vide *Neuropteris Huttoniana*).

Caulerpa (?) *selaginoides* occurs in the Marl-slate at Thrislington Gap, Midderidge (Sedgwick), Cornforth, Whitley, Cullercoats Bay, Brussleton, and Thickley, but nowhere is it very common. Geinitz records it as occurring in the equivalent rock (Kupferschiefer) at Mansfeld, Ilmenau, and Reichelsdorf; and in the lower Zechstein of Corbusen, Germany. The so-called *Pinna* (?) *prisca* is stated to occur in the Kupferschiefer of Merzenberge near Gera, between Milbitz and Thieschütz.[2]

[1] Brongniart, Histoire des Végétaux Fossiles, p. 23, 1828.

[2] A privately published lithograph appeared a few years since, representing a specimen of a gigantic Fucus, apparently of the genus *Halymenia*, found in the New Red Sandstone at Woodside, on the Mersey. As it is questionable whether this formation belongs to the upper division of the Permian system, or the inferior portion of the Trias, it has been deemed advisable to allude to this fossil only thus incidentally. For the same reason, a mere notice must suffice for the fucoids discovered by Mr. J. S. Dawes in probably the same formation, between Birmingham and Walsall. (Vide Report of the British Association, held at Manchester, 1842, p. 47; Transactions of the Sections.)

Class Acrogenæ, Ad. Brongniart, 1843.

Protophyta, *Endlicher.*
Cryptogames vasculares, *Ad. Brongniart.*
Acrogens, *Lindley.*

Diagnosis.—"Stems and leaves distinguishable."[1] (Lindley.)

This group, which differs from the last in possessing a vascular system, embraces the Mosses, Ferns, Lycopodiaceas, Equisetaceas, and some other allied plants, all of which, with the exception of the first and last, are known to occur, or to have related to forms in the Permian system.

Sub-class Filicales, Lindley.

Diagnosis.—"Vascular acrogens, with marginal or dorsal one-celled spore-cases, usually surrounded by an elastic ring; and spores of only one kind."[2] (Lindley.)

Dr. Lindley divides Ferns into three orders: *Ophioglossaceæ* (Adders' Tongues), *Polypodiaceæ* (ordinary Ferns), and *Danæaceæ* (Daneworts, tropical plants). The Permian species next to be described appears to belong to the second group.

Order Polypodiaceæ.

Diagnosis.—"Spore-cases ringed, dorsal or marginal, distinct, splitting irregularly."[3] (Lindley.)

Genus *Neuropteris*, Ad. Brongniart.

Diagnosis.—"Leaves bipinnate, or rarely pinnate; leaflets usually somewhat cordate at the base, neither adhering to each other, nor to the rachis, by their whole base, only by the middle portion of it; midrib vanishing at the apex; veins oblique, curved, very fine, dichotomous. *Fructification:* sori lanceolate, even (covered with an indusium) arising from the veins of the apex of the leaflets, and often placed in the bifurcations."[4] (Ad. Brongniart.)

This is an extinct genus of Ferns which abounded during the early ages of the world, as remains of it are very common in the coal formation: several species also occur in the Jurassic rocks; but only one is known to belong to the Permian deposits of Britain.

[1] The Vegetable Kingdom, p. 4, 1847.
[2] Op. cit. p. 74.
[3] Op. cit. p. 78.
[4] Histoire des Végétaux Fossiles, p. 226; Fossil Flora, vol. i.

Neuropteris Huttoniana, *King*. Plate 1, Fig. 4.

(?) One of the "Two species of Ferns" cited by *Sedgwick*. Trans. Geol. Soc. Lond. 2d series, vol. iii, p. 120, 1829.

Neuropteris Huttoniana, *King*. Catalogue, p. 5, 1848.

It is impossible to draw up a diagnosis of this Fern from the imperfect state in which it is generally found. The pinnules, of which only single or isolated examples appear to have been noticed, display the venation rather imperfectly: they resemble the pinnules of *Neuropteris gigantea* in form, at least, such as they are represented by Sternberg in the 'Flora der Vorwelt,' pl. xxii; but the veins are wider apart, somewhat as in *N. heterophylla*. The form of the pinnules is somewhat oblong: they have an indistinct midrib: and the veins, several of which apparently rise from the base, become forked as they approach the margin.

Professor Sedgwick notices two Ferns in his paper, but it is suspected that the one not cited in the synonomy under the present head, and which has not yet occurred to the writer, is the *Caulerpa* (?) *selaginoides*, a view apparently sanctioned by what has already been stated under this species.

Neuropteris Huttoniana occurs sparingly at Thrislington Gap, Midderidge, Brussleton, and East Thickley, in the Marl-slate.[1]

Sub-class Lycopodales, Lindley.

Diagnosis.—"Vascular acrogens, with axillary or radical one- or many-celled spore-cases, and spores of two sorts."[2] (Lindley.)

This group comprises the two orders *Lycopodiaceæ* and *Marsilaceæ*, to which it is proposed to add another, *Lepidodendraceæ*, which is represented by several palæozoic forms.

Order Lepidodendraceæ, Sternberg.[3]

Lepidodendreæ, *Unger*.
Sagenariaceæ, *Corda*.

Diagnosis.—Arborescent plants having a stem, with a rather large pith, consisting of perpendicularly elongated parenchyma, and surrounded by a narrow, completely-closed cylinder (medullary sheath ?), composed of irregularly-arranged, striated vessels. Encircling the cylinder is a broad zone of spheroidal parenchyma, surrounded by

[1] A remarkable Fern (?), figured and described in the 'Fossil Flora,' vol. iii, p. 201, under the name of *Dictyophyllum crassinervum*, has been found in the (Permian or Trias?) New Red Sandstone, near Liverpool.

[2] The Vegetable Kingdom, p. 69, 1847.

[3] Sternberg considered this a "Family" group, which he named "*Lepidodendron*."

another zone of a similar but denser tissue: the whole inclosed by a cuticle of radiately-disposed parenchyma. Bundles of spiral or striated vessels pass off from the outside of the (?) medullary sheath into the leaves, the collective bases of which, in the form of lozenge-shaped prominences, cover the stem in quincuncial order.

Bothrodendron, Lepidodendron, and some other forms, characterise the group.

Genus *Lepidodendron*, Sternberg.

Diagnosis.—"Stems dichotomous, covered near their extremities by simple, linear, or lanceolate leaves, inserted upon rhomboidal areolæ; lower part of the stems leafless; areolæ (longer than broad) marked near their upper part by a minute scar, which is broader than long, and has three angles, of which the two lateral are acute, the lower obtuse; the latter sometimes wanting."[1]

The late investigations of Dr. Jos. Hooker on the fructification of *Lepidodendron* have completely demonstrated its lycopodal character,[2] which had been rendered extremely probable by the previous researches of Lindley, Brongniart, and Morris, particularly by the latter, who, several years since, described and figured the tripartite spores of this genus, discovered by Mr. J. Prestwich in the coal formation of Coal Brook Dale.[3] Although the fructification of *Lepidodendron* agrees very closely with that of *Lycopodium*, the character of its tissues removes the genus not only from the latter, but favours both genera, being placed in distinct ordinal groups.

Lepidodendrons, in their foliage and external appearance, evidently bore a striking resemblance to some of our recent coniferous plants; but these are the only points of agreement, as their tissues and fructification place them in a much lower division of the vegetable kingdom. They may be said to have been gigantic Lycopodales, rivalling in stature and simulating in appearance some of the Conifers of existing forests.

Lepidodendron (?)

Lepidodendron, *King*. Catalogue, p. 5, 1848.
— *Howse*. T. N. F. C. vol. i, p. 264, 1848.

Specimens of *Lepidodendron* are occasionally found in the Lower New Red Sandstone Quarry, between Westoe and South Shields. There is one in the Newcastle Museum from this locality; but it is so imperfect as to render the making out of its specific character an impossibility.

[1] Fossil Flora, vol. i.

[2] "Remarks on the Structure and Affinities of some Lepidostrobi," by Dr. Jos. Hooker, F.R.S., &c., inserted in the 'Memoirs of the Geological Survey of Great Britain,' &c. vol. ii, part ii, 1848.

[3] Transactions of the Geological Society of London, 2d series, vol. v, pl. xxxviii, figs. 8, 9, 10.

Sub-class Calamitales, King.

It is proposed to adopt provisionally a new group in which to include the extinct genus *Calamites*, which, from its histology and general aspect, does not appear to belong to any yet established. From what is known of the genus just named, the sub-class *Calamitales* may be characterised as consisting of plants having jointed stems and branches, with a distinct pith, surrounded by a ligneous (or ligneo-vascular) zone, which is intersected by medullary rays, and composed of striated vessels or tubes arranged in radiating series. Considering the histological character just given, this group may, with some propriety, be separated from the class *Acrogenæ*, and placed among the Dicotyledons, as originally suggested by Dr. Lindley.[1]

Genus *Calamites*, Suckow.

Diagnosis.—"Stems jointed, regularly and closely furrowed, hollow, divided internally at the articulations by a transverse diaphragm, covered with a thick cortical integument. (? Leaves verticillate, very narrow, numerous, and simple.)"[2]

It is necessary to mention that the above diagnosis is incorrect so far as relates to the stems being "hollow." From specimens in iron-stone nodules found in the collieries of St. Berain and St. Leger, M. Ad. Brongniart has arrived at the conclusion that the fossils termed *Calamitea* by Cotta, are in reality Calamites with the tissues mineralized.[3] Mr. Dawes has also been fortunate in the discovery of specimens leading to the same conclusion.[4]

Calamites (?)

Calamites, *King*. Catalogue, p. 5, 1848.
— *Howse*. T. N. F. C. vol. i, p. 264, 1848.

A specimen resembling *Calamites Mougeotii*, now in the Newcastle Museum, was some years since found in the Lower New Red Sandstone Quarry, between Westoe and South Shields.

[1] Fossil Flora, vol. i, p. 53.

[2] Idem, vol. i.

[3] "Observations sur la Structure intérieure du Sigillaria elegans," &c., in Archives du Muséum d'Histoire Naturelle, tome i.

[4] The Quarterly Journal of the Geological Society, vol. v, p. 31, 1848.

Sub-class SIGILLARALES, King.

Diagnosis.—Arborescent plants, having stems with a large pith encircled by a narrow striato-tubular (ligneous?) cylinder, the tissue of which is intersected by medullary rays, and arranged in radiating series. On the inner side of the cylinder is a (reticulated?) medullary sheath, consisting of irregularly-arranged vessels. On the outside of the cylinder is a broad zone of cellular tissue, inclosed in a distinct cuticle. Bundles of spiral or striated vessels pass off from the medullary sheath, through the (ligneous?) cylinder, into the leaves, the collective scars of which (in the typical genus) are arranged in single rows on ribs, running longitudinally up the stem.[1]

The writer has not yet seen any reason for modifying the view which is advanced in his "Contributions" respecting the affinities of *Sigillaria;* he is therefore led to place the present group between "the highest vascular Cryptogams and the Cycadeous Gymnosperms."[2]

Order SIGILLARIACEÆ (*Sigillarieæ*), Corda.

Genus *Sigillaria,* Ad. Brongniart.

Diagnosis.—"Stem conical, deeply furrowed, not jointed; scars placed between the furrows in rows, not arranged in a distinctly spiral manner, smooth, much narrower than the intervals that separate them."[3]

Sigillarias have been trees, with a simple or branched stem, varying from twelve to a hundred feet in height, having large, wide-spreading, thickly-fibrilled roots (most probably *Stigmaria*), and *apparently* crowned with a pendant fern-like foliage (? certain species of Neuropteris).[4]

[1] Vide Ad. Brongniart's "Observations sur la Structure intérieure du Sigillaria elegans," &c. in the 'Archives du Muséum d'Histoire naturelle,' tome i; and the writer's "Contributions towards establishing the General Character of the Fossil Plants of the genus Sigillaria," in the 'Edinburgh Philosophical Journal,' vols. xxxvi, xxxvii, and xxxviii.

[2] Edin. Phil. Journal, vol. xxxviii.

[3] Fossil Flora, vol. i.

[4] This is the view which the writer published in the 'Edinburgh Philosophical Journal,' in 1845. Respecting the much-debated point connected with the root, he read at a meeting of the Natural History Society of Northumberland, Durham, and Newcastle-on-Tyne, in May 1842, a paper, one of the principal objects of which was to prove that "*Stigmaria,* which has hitherto been considered a distinct plant, is nothing more than the root of *Sigillaria.*" (Vide Literary Gazette, June 18, 1842, p. 425.) Subsequently, and it is believed at the Cork meeting of the British Association, held in 1843, Mr. E. W. Binney first announced his discovery of *Stigmaria* occupying the position of roots to *Sigillaria,* which induced the present writer to bring before the public, in the 'Edinburgh Philosophical Journal' for October 1843, an outline of his own views as contained in the paper already referred to, the publication of which was commenced in the succeeding number, under the title of "Contributions towards establishing the General Character of the Fossil Plants of the genus *Sigillaria.*" It is necessary to mention these

Sigillaria (?)

Sigillaria, *King*. Catalogue, p. 5, 1848.

Specimens of the genus under consideration occasionally occur in the Lower New Red Sandstone Quarry between South Shields and Westoe, but they are so very imperfect as to render it impossible to say whether or not they belong to any species identical with those found in the immediately subordinate Coal-measure beds.[1]

facts, as they appear to have been entirely overlooked by almost every one who has written of late on the subject. It may be added, that the writer does not think any evidence has yet come to light proving positively that *Stigmaria* is the root of *Sigillaria:* all that can be safely said is, that there are very strong evidences in its favour: this is the view which he advocated in the "Contributions," although a more decided one was taken in his previously published notices.

[1] From the occurrence of true Coniferous Gymnosperms in the Carboniferous rocks of England, one is induced to believe in the existence of this section of plants in the same geographical area during the Permian epoch. Some years ago, the Rev. Dr. Buckland read a paper at a meeting of the Geological Society, "On the Occurrence of Silicified Trunks of Large Trees in the New Red Sandstone Formation, or Poikilitic Series, at Allesly, near Coventry" (vide Proceedings of the London Geological Society, vol. ii, pp. 439-40), sections of which displayed the true discigerous vessels of Coniferous wood. Is the Allesly Sandstone Permian or Triassic?

The "small fragments of carbonized wood," and "carbonaceous matter apparently derived from vegetable fossils," noticed by Professor Sedgwick as occurring in "the Marl and Blue Shelly Limestone-beds of Palterton and Bolsover" (vide Trans. Geol. Soc. Lond., 2d series, vol. iii, pp. 81, 120), require to be alluded to in the present place. Perhaps the "many," "long," "compressed cylindrical stems, about one inch and a half in diameter, but without any external markings to indicate their origin," seen by the same gentleman (Op. cit., 2d series, vol. iii, pp. 107, 120), traversing the low beds in Welsea Quarry, between Nosterfield and Well, are the remains of Fucoids,—probably *Caulerpa selaginoides*.

ANIMALS.

Of the five primary divisions into which the Animal Kingdom may be divided, namely, *Spongia*, *Radiata*, *Articulata*, *Mollusca*, and *Vertebrata*, the whole had representatives during the remote period, the Natural History of which, pertaining to a limited area, it is proposed to describe in the present Monograph.

Sub-kingdom SPONGIA, Auct.

Σπογγος, *Aristotle.*
Spongia (Genus), *Linnæus.*
Ceratophyta spongiosa, *Schweigger.*
Porifera (Class), *Grant.*
Spongiadæ, *Fleming.*
Amorphozoa, *Blainville.*
Spongiaires (Family), *Milne Edwards.*
Gelatinifera, *Hogg.*

Diagnosis.—"Organized bodies growing in a variety of forms, permanently rooted, unmoving and unirritable, fleshy, fibro-reticular, or irregularly cellular, elastic and bibulous, composed of a fibro-corneous axis or skeleton, often interwoven with siliceous or calcareous spicula, and containing an organic gelatine in the interstices and interior canals; reproduction by gelatinous granules generated in the interior, but in no special organ."[1]

Dr. Grant, to whom naturalists are much indebted for some interesting particulars on Sponges, divides the group into the three orders—*Halinida* (with siliceous spicula), *Leuconida* (with calcareous spicula), and *Keratosa* (consisting principally of horny species);[2] but, as it is not yet ascertained to which of these groups the Sponges hereafter noticed belong, it is deemed advisable to waive all discussion on the several interesting points involved in the consideration, and to pass on to the genera to which they appear to belong, taking simply their external characters as the means of identification. It may be premised, that Mr. Bowerbank has demonstrated the

[1] Dr. Johnston, A History of British Sponges and Lithophytes, p. 78, 1842.

[2] British Annual and Epitome of the Progress of Science for 1838, p. 267. In addition to the orders proposed by Dr. Grant, the singular genus *Dysidæa*, Johnston, ("spongious, with imbedded inorganic grains of sand,") may hereafter be considered as the type of another order.

existence of Halinidas or Sponges with siliceous spicula in the Greensand;[1] and lately, Mr. Lonsdale has described a genus (*Conis*, a granulo-calcareous Sponge) belonging to the order *Leuconida*, from the same formation.[2]

Genus *Scyphia*, Oken.

Diagnosis.—"Stirps affixa, cava, simplex vel subramosa, cylindracea, ore aperto, e fibris reticulatis."[3] (Goldfuss.)

This genus, which is typified by the recent *Spongia fistularis*, Esper, embraces Sponges "with a reticulated tissue, and whose general form resembles a cylindrical or expanded tube, terminated by a large opening."[4] Goldfuss has figured several Jurassic species.

Scyphia tuberculata, *King*. Plate II, figs. 1 and 2.

Scyphia tuberculata, *King*. Catalogue, p. 5, 1848.

Diagnosis.—*Form* cylindrical. *Surface* tuberculated. With an axial excurrent canal, from which several smaller ones strike off to the surface; the superficial tubercles forming their apertures.

This Sponge appears to be scarce. It occurs in the Shelly Limestone at Humbleton Hill and Dalton-le-Dale.

Genus *Mammillopora*, Bronn.

Lymnorea, *Lamouroux*.

Diagnosis.—"Masses mammillated, finely porous and reticulated, agglomerated within a common calciform, wrinkled, adherent base."[5]

This genus was originally proposed by Lamouroux, whose name *Lymnorea* being preoccupied, Bronn was led to replace it in his 'Pflanzenthiere' and 'Lethæa' by the one herein adopted. The above diagnosis, from the 'Penny Cyclopædia,' has been used in preference to the one in German given by this author.

Mammillopora mammillaris, *King*. Plate II, figs. 3 and 4.

Manon mammillaris, *King*. Catalogue, p. 5, 1848.

Diagnosis.—*Form* mammillary polymorphous. *Pores* minute and polygonal.

This Sponge has some resemblance to the Jurassic *Mammillopora protogæa*, Bronn

[1] Proceedings of the Geological Society of London, vol. iii, p. 280.

[2] Quarterly Journal of the Geological Society, vol. v, part i, pp. 63-6.

[3] Petrefacta, Heft i, p. 4.

[4] Milne Edwards, in Lamarck's 'Animaux sans Vertèbres,' vol. ii, p. 578, 2d edition, 1836.

[5] Penny Cyclopædia, vol. xxii, p. 376.

(*Lymnorea mammillosa*, Lamouroux), but it does not display the large oscula on the summit of the mammillæ, characteristic of the latter. The want of large excurrent openings in this species has caused its removal from the genus *Manon*, in which it was formerly placed.

Mammillopora mammillaris occurs sparingly in the Shelly Limestone at Humbleton Hill.

Genus *Tragos*, Schweigger.

Diagnosis.—"Stirps e fibris densis, subgelatinosis; superficies ostiolis distinctis."[1] (Schweigger.)

The type of this genus is the *Alcyonium incrustans* of Esper, which belongs to the order *Halinida*. There is considerable doubt as to whether the following two Sponges ought to be placed in it.

Tragos Tunstallensis, *King*. Plate II, fig. 5.

Diagnosis.—*Form* irregularly infundibular. *Summit* expanded and slightly excavated. *Margin of the cavity* irregularly lobed. *Outer surface* uneven. *Substance* fibrous, with numerous, small, excurrent passages.

The usual size of this Sponge is half an inch in height, and three quarters in width. In its fibrous texture it resembles the *Tragos patella*, figured by Bronn in the 'Lethæa Geognostica,' pl. xvi, fig. 3.

It is occasionally found in the Shelly Magnesian Limestone at Tunstall Hill.

Tragos Binneyi, *King*. Plate II, fig. 6.

Diagnosis.—Infundibuliform; slightly excavated at the summit. *Surface* porous, and irregularly tuberculated.

This is a larger species than the last, occasionally measuring an inch and a half in width, and two inches in height. It appears to have been variable in its relative proportions, as some specimens are much less in height than in width; they have somewhat the appearance, however, of having been depressed by superincumbent pressure. None of the specimens examined show any excurrent openings on the outside, but it is suspected that these, as in many recent cup-shaped Sponges, were situated within the cavity: this part, however, is in general so filled up with mineral matter and casts of shells, that it is impossible to offer any decided opinion on this point. Where the outside is pretty clear of the investing mineral matter, there may be seen a few small pores, which, it may be safely concluded, were the openings of the

[1] Handbuch der Naturgeschichte der Skelettlosen ungegliederten Thiere, p. 422, 1820.

incurrent canals. The figure of this Sponge is reduced to half the size of the original specimen.

Mr. E. W. Binney, to whom I have much pleasure in dedicating this Sponge, has obtained several examples from the Red Marls at Bedford, ten miles west of Manchester, where it appears to be not uncommon.

Genus *Bothroconis*,[1] King.

Diagnosis.—A creeping sponge. *Surface* pitted. *Fibres* irregularly reticulated. *Excurrent openings* minute. Type, *Bothroconis plana*, King.

Being unacquainted with the chemical composition of its skeleton, I have nothing to offer regarding the affinities of this genus, except the suggestion, that it may be related to the *Conis*[2] of Mr. Lonsdale.

Bothroconis plana, *King*. Plate II, figs. 7, 7*a*.

Diagnosis.—A flat, wide-spreading Bothroconis. *Pits* cup-shaped, one sixteenth of an inch in diameter. Interstitial areas a little less than the pits in width.

The specimen from which figures 7, 7*a*, have been taken, is spread over an irregular surface about six inches in diameter, but owing to long exposure to atmospheric and other abrading influences, it is only in a few hollow, and consequently less exposed parts, where the characters are preserved with any distinctness. The magnified representation under figure 7*a*, Plate II, exhibits the regularly-margined, cup-shaped pits (*a*); and the irregularly-reticulated intervening areas, furnished with pores (*b*), which I am strongly disposed to regard as openings of the excurrent canals. This species appears to be related to the larger *Hydnopora* (?) *cyclostoma* of Phillips, (vide Geol. Yorksh., vol. ii, pl. ii, figs. 9, 10.)

I have only been able to find this interesting Sponge in the Shell-limestone at Tunstall Hill.[3]

[1] Etym. Βοθρὸς, *fovea*; and κόνις, *pulvis*.

[2] The Quarterly Journal of the Geological Society, vol. v, pp. 55-66, June, 1848.

[3] Mr. Jones informs me that he has found in the Shell-limestone of Tunstall Hill a minute Sponge (?), globular, and irregularly pitted, of about $\frac{1}{70}$ inch diameter.

Class Foraminifera, D'Orbigny.[1]

Synonyms. Nautili et Orthocerata, Auct. prior.
Polythalama, Cephalopoda, *Lamarck*. 1812. Extrait de son Cours.
— vel Multilocula, Cephalopoda, *Latreille*. 1825. Fam. nat. du Règne Animal.
Cellulacea et Polythalamacea, — *Blainville*. 1825. Manuel de Malacol.
Asiphonoidea, Cephalopoda, *De Haan*. 1825. Monograph. Ammonit.
Foraminifera, — *D'Orbigny*. 1825. Annal. des Sciences nat., tom. vii, 1826.[2]
— — *Cuvier*. 1828. Règne Animal., édit. nouv.
Symplectomères, Rhizopodes, } Infusoires, *Dujardin*. 1835. Annal. des Sciences nat., sec. sér.
Polythalamia, Bryozoa, *Ehrenberg*. 1838. Abhand. der Akad. Berl.
Foraminifères, "entre les Echinoderms et les Polypiers," *D'Orbigny*. 1846. Foraminif. foss. Vienne.
Foraminifera, "immediately above the Porifera," *Williamson*. 1849. Trans. Microscop. Soc., vol. ii.

A group of minute, shelled animals, belonging to the sub-kingdom Acrita; marine, inhabiting sea weeds and the sea bottom; generally free, but sometimes attached to shells, corals, &c.

Animal gelatinous,[3] occupying a calcareous shell, which is formed of a succession of cells or chambers, arranged in a straight, spiral, or agglomerated manner. The cells communicate one with another either by one or more apertures,[4] or by a narrow neck or tube, through which the animal matter is continued from cell to cell.[5] The cells are either separate from each other, or more or less envelope one another. The later cells are progressively larger than the earlier cells. The shell is generally perforated with foramina[6] for the passage of retractile filaments (pseudopodia).

The occurrence of Foraminifera in the Permian Formation not having hitherto been

[1] By Mr. T. Rupert Jones.

[2] M. d'Orbigny's researches in the natural history of this group were commenced in 1819. The paper containing his Tableau des Céphalopodes was read in 1825, and published in the Ann. Sc. nat. for 1826.

[3] Like the substance of Hydra. The presence of a stomach is doubtful.

[4] Hence the appellation "Foraminifera."

[5] Each new articulation of the animal being produced by gemmiparous generation from the aperture at the extremity of the preceding cell, and each cell being a repetition of the former cells, the character of the connexion between the cells is shown by the external orifice of the last cell.

[6] With regard to the perforated appearance of many of the Foraminifera, especially the hyaline species, I would observe that the apparent apertures, as shown by transmitted light, are really, when seen by reflected light, merely punctations or thinned doubly-concave spaces in the shell. In the investing coats of the Nummulite, which appear to be perforated with minute tubules, the separate flakes, when favorably mounted, are seen to be imperforate, but bearing innumerable and scarcely-separated transparent spots; and these, when the coats are arranged one on another, are placed in so regular an order from within outwards, that in an oblique section, fine transparent lines resulting therefrom give the whole shell the

noticed, and twelve species only having been described as belonging to the earlier strata,[1] the few species which we now bring forward may perhaps be regarded as of some interest. The presence of so few species of this group in the early formations tends to strengthen the remark made by M. d'Orbigny, that the Foraminifera appear to have been subject to a somewhat regular progression both in character and number, the simple forms occurring in the early formations, and that but rarely, and the most complicated not appearing until the cretaceous, tertiary, and recent epochs, and then with profusion. Further observations, however, by increasing our knowledge of the microzoa of the palæozoic rocks, may perhaps somewhat modify this interesting hypothesis.

Of the two genera, Dentalina and Textularia, found in the Magnesian Limestone, the first (a simple form) is the most common, and is locally abundant; the latter (a more advanced or complex form) is stated by M. d'Orbigny to appear for the first time in the Neocomian series. Prof. Ehrenberg, however, in March 1843 (Monats-Bericht Berl. Akad.), described a Textularia of the Russian Carboniferous rocks, and Mr. Phillips has pointed out the existence of this genus both in the Mountain-limestone, and the Oolite of Yorkshire, and we have now two species to add from the Permian group.

The specimens under notice were obtained from some thin calcareous slabs, occurring on the sea coast near Byers' Quarry, between Sunderland and South Shields, composed of a hard gray crystalline Limestone, with an uneven surface, here and there exhibiting a covering of fine calcareous grit. The latter, almost if not quite as hard and compact as the crystalline Limestone, had been subjected to the action of the waves and weather, and afforded casts and shells of Mollusca, Entomostraca, and Foraminifera standing in relief, and more or less perfectly preserved. The crystalline Limestone also afforded, on fracture, many specimens of Entomostraca, and probably may have been as rich in organic remains as the less altered gritty covering.

Besides the species figured, a few other less distinct forms occurred in this Limestone, as well as in a more friable and yellowish stone from Humbleton and Tunstall Hill.

appearance of being tubuliferous. The structure of the outer rim, however, of the Nummulite, and some other genera, may be truly tubular or foraminated, admitting the passage of pseudopodia. In Textularia, Valvulina, Bulimina, and others, in which the shell is not hyaline, but opaque and friable, the thinned or transparent spaces in the shell are fewer, and very irregular in size and distribution; and here tubular structure, both apparent and real, is altogether absent, as also in the Agathistegia, in which the shell is still more homogeneous and opaque.

[1] The Carboniferous Limestones of Russia. (See Geol. Russia, vol. ii, p. 382.) Evidences of Foraminifera were observed in Mountain-limestone by Messrs. Tennant and Darker in 1839, and by Mr. Lonsdale in 1840, but the genera were not ascertained; and Mr. Phillips, both in 1841 (Palæoz. Foss. Devon., p. 153) and in 1846 (Remains of Micros. Anim., Yorkshire, p. 5), refers to the presence of Foraminifera in the Mountain-limestone, and in the Devonian and Silurian rocks. See also Mr. Williamson's paper on some Microscopic Objects, &c. (Manchest. Mem., 1847, p. 88). An additional species, *Nodosaria fusuliniformis*, has been noticed by Prof. M'Coy in the Carb. Limestone of Tyrone (Ann. Nat. Hist., 1849).

Order STICHOSTEGIA, D'Orbigny.

Genus *Dentalina*, D'Orb.

Generic characters.—*Shell* elongate, conical, equilateral, slightly curved; formed of a series of chambers, more or less globose, arranged end to end, on a single axis.

Aperture small, round, on apex of the last chamber.

No. 1. DENTALINA PERMIANA, *nob.* Tab. VI, fig. 1.

	INCH.
Length,	$\frac{1}{23}$
Thickness,	$\frac{1}{163}$

Shell formed of about nine smooth, oval cells. The early cells subglobose, the later cells longer than broad. Last cell somewhat beaked. *Sutures* shallow.

Not rare, both in the young and adult state, at Byers' Quarry.

Several species of Dentalina approach this form, especially *D. elegans*, D'Orb. (tertiary), Foram. foss. Vienne, p. 45, n. 21, tab. i, figs. 52-6, and *D. gracilis*, D'Orb. (cretaceous), Mém. Soc. Géol. France, tom. iv, 1re partie, p. 14, n. 4, tab. i, fig. 5.

No. 2. DENTALINA KINGII, *nob.* Tab. VI, figs. 2, 3.

	INCH.
Length,	$\frac{1}{28}$
Thickness,	$\frac{1}{125}$

Shell formed of about eight globose cells, each bearing ten to twelve ribs. *Sutures* excavated.

Of frequent occurrence, at Byers' Quarry.

D. Kingii is very similar to *D. multicostata*, D'Orb. (cretaceous), Mém. Soc. Géol. France, tom. iv, 1re partie, p. 15, n. 8, tab. i, figs. 14, 15; which latter, however, has more than double the number of ribs. This form is closely allied to that of *Nodosaria sulcata*, Nilss. (cretaceous), *Nod. elegans*, Münst. (tertiary), *Nautilus obliquus*, Gualt. (recent), *N. jugosus*, Montag. (recent), and *Nod. Rapa*, D'Orb. (recent).

No. 3. DENTALINA (?) Tab. VI, fig. 4.

	INCH.
Length,	$\frac{1}{30}$
Thickness,	$\frac{1}{125}$

Crystalline and transparent cast of shell formed of two oval, oblique cells; last cell beaked; each cell marked with a diagonal fold, as if it were a tube bent on itself.

We have met with three instances of this anomalous fossil, in the same locality as the last.

Order ENALLOSTEGIA, D'Orbigny.

Genus *Textularia*, Defrance.

Generic characters.—*Shell* conical or wedge-shaped, equilateral, formed of cells arranged (like a band of hair) alternately, on the same plane and on two distinct parallel axes. *Aperture* semilunar, on the inner side of the last cell.

No. 1. TEXTULARIA TRITICUM, *nob.* Tab. VI, fig. 5.

	INCH.
Length,	$\frac{1}{30}$
Thickness,	$\frac{1}{140}$

Shell conical, somewhat flattened on two of its sides; its horizontal section oval; composed of nine subglobose cells. *Sutures* deeply sulcated.

This species is found at Byers' Quarry; rare.

No. 2. TEXTULARIA CUNEIFORMIS, *nob.* Tab. VI, fig. 6.

	INCH.
Length,	$\frac{1}{62}$
Thickness,	$\frac{1}{142}$

Shell wedge-shaped, having four equal sides; composed of fourteen to sixteen flattened cells. *Sutures* shallow.

We have seen three or four specimens of this species from Byers' Quarry. A very similar form occurs in the Gault of Folkstone.

Genus *Spirillina*, Ehrenberg.

Gen. char.—Microscopic shell, spiral, orbicular, porous, hyaline, smooth. (Ehrenb.)

After the execution of the plates, Mr. King found in the Shell-limestone at Tunstall Hill a specimen of a spiral shell, apparently identical with *Spirillina*, Ehrenb.

The specimen is a horizontal section, $\frac{1}{50}$ inch diameter, having six volutions, and without any traces of septa.

The alliances of this little Serpula-like shell are at present uncertain. Professor Ehrenberg and Mr. Williamson have noticed similar shells in the recent state, and Mr. Strickland a species from the Lias.

In his paper on the "Recent Polythalamia and Infusoria of North and South America,"[1] Professor Ehrenberg has placed amongst the Polygastrica a spiral, foraminated, unchambered, six-whorled shell, from Vera Cruz, with the above-cited characteristics. The specimen having several young shells within it (passim testulis pullis fœta), received the appellation of *Sp. vivipara*. Mr. Williamson, in his paper on "Some of the Microscopical Objects found in the Mud of the Levant, &c.,"[2] notices and figures a minute, spiral, transparent Foraminifer, having no trace of septa, which, except that it contains no young shells, appears to be identical with Professor Ehrenberg's species; and at page 87 Mr. Williamson notices how closely the specimens he has seen resemble the one found by the Rev. P. B. Brodie in the Lias, and figured and described by Mr. Strickland, in the 'Geol. Journal,' vol. ii, p. 30, as *Orbis infimus*.

We have from the Lias a cast in pyrites of this little spiral shell, $\frac{1}{75}$ inch diameter, one surface concave, the other nearly flat, composed of six volutions partially covering one another, convex on their outer, and concave on their inner or enveloping surface; a portion of the shell, soft, white, and apparently destitute of foramina, is still adherent, especially between the volutions; the pyrites in the inner whorls is somewhat mammillated, and has some irregular transverse scorings, but no decided evidence of septa exists.

A specimen from the Miocene Sand of Bordeaux, $\frac{1}{80}$ inch diameter, has six sub-cylindrical volutions, with a central space, and (mounted in balsam) exhibits an appearance that at first sight seems to be the result of concamerations; but on closer examination, the outer wall of the volutions that have been covered by the external whorls seems to be perforated by large pear-shaped passages; this appearance is more visible on one (the concave) surface than on the other (the flat) surface of the shell, and is the result of surface-markings. The flat surface is sub-concentrically marked with coarse, rounded punctations, and the concave surface bears a series of large pear-shaped pits[3] along the sutures of the volutions, and a cluster of punctations on the central space. The shell of this individual is not foraminated as Professor Ehrenberg's and Mr. Williamson's specimens are described to be.[4]

Although, according to these authors, the shell of the recent specimens is more or less perforated with foramina, that is, beset with transparent points,[5] a character generally found amongst these microscopic, shelled Acrita, yet the absence of septa, or rather of the evidence of this little microzoon having been built up of a succession

[1] Abhand. König. Akad. Wissenschaft. Berlin, 1841, p. 442.

[2] Page 45, pl. ii, fig. 34, printed from the Manchester Lit. Scient. Soc. Mem. 1847.

[3] Formed apparently by regular depressions on the enveloping edge of the investing whorl.

[4] It is just possible, however, that transparent pittings have been regarded as foramina in these as in other instances. (See note 6, page 15.)

[5] For the same reason, viz. its punctated surface, the Bordeaux specimen has some claim to an alliance with the Foraminifera.

of individual cells, a mode of structure still more characteristic of *Foraminifera*, D'Orb. (*Polythalamia*, Ehren.), is very inimical to the classing of Spirillina with the Foraminifera.

Professor Ehrenberg has placed *Sp. vivipara* among the Polygastrica, but to this group it appears even more strange than to the Foraminifera.

The further examination, however, of recent specimens will probably decide to what family this minute organism really belongs. In the mean time we may direct observation to the fact of the existence of the genus, and probably the same species, not only in the recent state (in the Gulf of Mexico and the Mediterranean) and in the super-cretaceous deposits (Bordeaux), but also in the Lias and the Magnesian Limestone. Although so like a Serpula in its form, the fact of its occurring in these various deposits strongly militates against its being an Annelid, and places it amongst such low organisms as Polygastrica or Polythalamia, which preserve generic and even specific characters throughout very many geological epochs.

Sub-kingdom RADIATA, Cuvier.

Zoophytes, *Auct.*

This portion of the Animal Kingdom is divisible into five classes, viz.: *Infusoria*, *Entozoaria*, *Malactinia*, *Polyparia*, and *Echinodermata*, the last two of which are only known as members of the Permian Fauna.[1]

Class Polyparia (*Les Polypes*[2]), Lamarck, 1801.

The latest writers on this group divide it into what may be termed two sub-classes, viz. *Nudibrachiata* and *Ciliobrachiata*, respectively characterised by the absence or presence of cilia on the tentacles or brachial appendages surrounding the oral aperture

[1] I have adhered throughout this Monograph to the law of priority only as regards the names of species, genera, and families. With respect to higher groups, I have used such names for them as appear to be the most suitable, and I have often altered the value of the groups on which such names have been imposed: thus Blainville's name *Palliobranchiata* is more scientifically correct than Cuvier's *Brachiopoda;* besides, it is expressive of the great distinguishing character of the group to which it belongs. Blainville's name has therefore been preferred, though the value of the group of Molluscs, to which the author of the 'Manuel de Malacologie' applied it, has been raised to the rank it holds in the Cuvierian system.

[2] Les Polypes "ont été ainsi nommés, parce que les tentacles qui entourent leur bouche ces font un peu ressembler au poulpe, que les anciens appelaient polypus."—Cuvier, Règne Animal, tome iii, p. 289, 1830.

of the polyps. The first sub-class may be conveniently divided into two orders, *Hydroida* and *Actinoida;* but the second does not as yet appear to be resolvable into more than one, for which it is intended to use in a popular sense the name *Bryozoa*, originally proposed for the group itself by Ehrenberg. In the first and lowest order, *Hydroida*, digestion is performed by the secretion of a simple sac excavated in the gelatinous and granular substance of the animal's body. In the second, *Actinoida*, the digestive sac, which, like the first, throws out the rejectamenta by the same aperture as that which receives the nutriment, is suspended by a series of vertical folds of membrane, in a distinct abdominal cavity, to the outer parietes of the body. In the sub-class *Ciliobrachiata,* the alimentary canal, which is likewise suspended loosely in an abdominal cavity, is provided with a distinct mouth and outlet.[1]

It is uncertain whether the whole of the orders just noticed have representatives amongst the Corals hereafter to be described. There are strong objections to any of them being considered as Hydroidas; but there is nothing to oppose the placing of most of them in the other divisions.

Sub-class Nudibrachiata, Farre.

Waiving the *Hydroida*, for the reason just stated, it is proposed to pass at once to the order *Actinoida* established by Dana, who divides it into two sub-orders, *Actinaria* and *Alcyonaria.*

Sub-order Actinaria, Dana, 1847.

Zoocorallia polyactinea, *Ehrenberg.*
Zoantha, *Blainville.*
Les Zoantaires, *Audouin et Milne Edwards.*
Zoophyta Helianthoida, *Johnston.*

Diagnosis.—"Tentacles six, twelve, or more in number, not papillose (with few exceptions), and perforate at the apex; often coralligenous; coralla calcareous, very rarely corneous, cells radiate with lamellæ."[2] (Dana.)

The members of this division are represented on the British coasts by the naked Actinias or Sea Anemones, everywhere distributed on our rocks; by the single species *Zoanthus Couchii,* which seems to be confined "to the Cornish part of the British Channel;" and by a few forms of lamelliferous Corals rarely to be met with in northern

[1] Vide Owen's Lectures on the Comparative Anatomy and Physiology of the Invertebrate Animals, p. 82.

[2] Structure and Classification of Zoophytes, p. 113, 1847.

seas.[1] The Madrepores, Astreas, Fungias, and other calcareous forms so abundant in warmer climates, are familiar productions of Actinarian Zoophytes.

The animal is generally of a cylindrical form; often crowned with a large number of naked, tubular tentacles, encircling a single contractile orifice, which serves the double purpose of an ingress and egress opening. The orifice leads into a short gullet, terminating in a large digestive cavity, which is lined with numerous vertical membranous folds, constituting, apparently, the principal seat of reproduction. These folds are supported by the radiating plates to be seen in Astreas and Fungias, and in the figure of *Calophyllum Donatianum* given in Plate III, fig. 1.

Family Cyathophyllidæ, Dana.

Diagnosis—"Coralligenous, the corallum of each polyp, internally at middle, usually transversely or obliquely cellular."[2] (Dana.)

This family embraces a number of Palæozoic genera, such as *Cyathophyllum*, *Strombodes*, and the one next to be noticed.

Genus *Calophyllum*, Dana.

Polycælia, *King*.

Diagnosis.—"Quite simple, caliculato-ramose, or aggregate. Corallum within transversely septate; cells concave, regularly stellate; no internal dissepiments between the lamellæ and the sides of the corallum, therefore not cellular." (Dana.)

At the time I published the paper "On some Families and Genera of Corals," in the 'Annals and Magazine of Natural History,' 2d series, vol. iii, April, 1849, I was not aware that Mr. Dana had previously established a genus under the name of *Calophyllum* corresponding to my *Polycælia*, typified by a Permian Coral, which had been originally named *Turbinolia Donatiana*.

Both genera being evidently the same, I readily adopt the name which belongs to it by right of priority; but lest it should hereafter be found necessary to subdivide the genus as given by Mr. Dana, it has been deemed necessary to repeat the diagnosis of *Polycælia* as published in the 'Annals.'

"A (?) simple Cyathophyllidia. *Form* conical. Walls solid. *Primary vertical plates* converging to within a short distance of the centre. *Secondary vertical plates* reaching

[1] Dr. Johnston, in his 'History of British Zoophytes,' 2d edition, notices four genera of British lamelliferous Corals, viz. *Pocillopora*, *Oculina*, *Turbinolia*, and *Caryophyllia*. With regard to *Oculina*, on the occurrence of which in our seas there has been considerable doubt, a brief account by the writer is given, in the 'Annals of Natural History,' vol. xix, p. 279, of a beautiful specimen of the species *O. prolifera*, measuring eleven inches in diameter, which was brought up off the coast of Shetland, where it had undoubtedly been living.

[2] Structure and Classification of Zoophytes, p. 115.

about half way to the centre. *Transverse plates* horizontal, at irregular distances from each other, and extending quite across the cavity. *Chambers or lamellar interspaces* capacious compared with those of other Cyathophyllidias. *Reproduction* within the polypiferous cup.

"Type, *Turbinolia Donatiana*, King, 'Catalogue of the Organic Remains of the Permian Rocks of Northumberland and Durham,' p. 6.

"This genus differs from most *Cyathophyllidæ* in its structural characters; but it appears to be nearest related to *Cyathophyllum*, taking as its type the (?) tri-areal *C. plicatum* of Goldfuss, which is the first species described under the genus. (Vide 'Petrefacta,' pl. xv, fig. 12.)"[1]

It may be added, that the difference just alluded to consists in the absence, in *Calophyllum*, of a distinct vesicular axis or central area, and a vesicular wall or outer area. The genus is strictly uni-areal in its structure, possessing, in an unusually developed form, merely the intermediate area of transverse and vertical plates found in most of its associated genera.

Calophyllum Donatianum, *King*. Plate III, fig. 1.

Turbinolia Donatiana, *King*. Catalogue, p. 6, 1848.

Diagnosis.—A Calophyllum: vermiform: gradually enlarging from the base upwards: transversely wrinkled and longitudinally striated on the outside. *Vertical plates* dense and somewhat apart from each other: primaries four; secondaries sixteen. *Transverse plates* horizontal, rather thick, and at irregular distances from each other. *Polypiferous cell* shallow.

This Coral bears a striking resemblance to Count Münster's *Cyathophyllum radiceforme* (Beiträge, Heft 4, pl. ii), found in the calcareous Marl-beds of St. Kassian, in the Tyrol.

The specimen figured, which is the only one of the species known to me, was procured at Humbleton Hill, in the upper bed of Shell-limestone.

Petraia, Münster.[2]

Turbinolopsis (fungites), *Phillips*.
Cyathophyllum (profundum), *Geinitz*.
Streptoplasma, *Hall*.

Diagnosis.—"Polyparium unattached, undivided, conical, deeply concave (hypocrateriform) on the lamelliferous surface. Lamellæ denticulated on the edges, plain on the sides, alternately long and short. External surface more or less striated longitudinally in correspondence with the lamellæ, and marked by annular lines of growth." (Phillips.)

[1] Annals and Magazine of Natural History, 2d series, vol. iii, p. 388.

[2] Beiträge, Heft i, p. 64.

The original description, which appeared in the 'Beiträge,' of *Petraia* being so imperfect,—Count Münster having drawn it up under the belief that he was describing a genus of Gasteropodous shells,—I have been compelled to adopt the diagnosis given by the author of the 'Palæozoic Fossils of Cornwall, &c.'[1] The views, too, of Professor Phillips on the analogies of this genus may very appropriately follow as a pendant. "In the single unattached mass and denticulated lamellæ of unequal lengths, we see the closest analogy with Fungia and Turbinolia (with the latter of which they have been commonly united); while the deeply concave, lamelliferous disc and the absence of horizontal septa seem to give generic peculiarity. The lamellæ are not granular on their sides."

The genus is not known to occur in a recent state: all the species that have been described belong to the Palæozoic formations, unless we include in it the *Anthophyllum venustum* of Münster found in the (?) Triassic beds of St. Kassian.

PETRAIA PROFUNDA, *Germar*. Plate III, fig. 2.

(?) ASTRÆA PEDICULATA, *D.* Phillips, Encyc. Met. vol. vi, p. 615, 1834.
(?) A LAMELLIFEROUS CORAL, *Phillips*. Lardner's Cycl. Geology, vol. i, p. 190, 1837.
CYATHOPHYLLUM PROFUNDUM, *Germar*. Versteinerungen, p. 37, 1840.
— — „ Geinitz, N. Jahrbuch, 1842, p. 579, pl. x fig. 14*a*.
— — „ Geinitz, Gæa, von Sachsen, p. 98, 1843.
— — „ De Verneuil, Bull. Soc. Géol. France, 2me série, vol. i, p. 23, 1844.
PETRAIA N.S., *King*. De Verneuil, Op. cit.
— — „ Geol. Russ. vol. i, p. 221, 1845.
CYATHOPHYLLUM PROFUNDUM, *Germar*. Op. cit.
PETRAIA DENTALIS, *King*. Catalogue, p. 5, 1848.
CARYOPHYLLIA QUADRIFIDA, *Howse*. T. N. F. C. vol. i, p. 260, 1848.
CYATHOPHYLLUM PROFUNDUM, *Germar*. Geinitz, Versteinerungen, p. 17, pl. vii, fig. 7, 1848.

Diagnosis.—"*Form* conical, and slightly curved. *Cavity* deep, and longitudinally furrowed. *Plates* of two lengths; the longest five or more in number, plain edged (?) and reaching half way to the centre; the shortest from one to four in number. *Lamellar interspaces* with two very finely-denticulated, slightly prominent ridges."[2]

The following description of *Petraia profunda* is copied from Geinitz:

"Umgekehrt lang-kegelförmig mit tief herabgehender konischer Mündung. Die starken Längslinien der Oberfläche, deren man auf einer Hälfte oben gegen fünfzehn zählt, werden unregelmässig und häusig durch concentrische erhöete und vertiefte Wachsthumsringe und Linien unterbrochen. Das untere Ende des Ganzen ist gewöhnlich etwas seitwärts gebogen. Die Mündung geht bis zur Mitte der Höhe,

[1] Palæozoic Fossils of Cornwall, &c., p. 1.
[2] King, Catalogue, p. 5, 1848.

sogar noch tiefer herab. Die Vertheilung der Querlamellen, deren in der Mitte der Länge etwa 24 vorhanden sind, ist nicht ganz regelmässig. In einem durchbrochenen Exemplare stehen die vier bis zur Axe laufenden fast im Kreuz, und zwischen ihnen fünf oder sechs kleinere, welche auch ziemlich abwechselnd kleiner und grösser sind."[1]

The beautiful specimen figured by Geinitz, and from which the above description is taken, is conical, with the lower or pointed end slightly curved: the aperture is very deep, occupying the upper half of the specimen, or more: externally it is longitudinally striated, and transversely rugose. The plates, of which there are in all about twenty-four, vary in length: there are four long plates dividing the Coral into as many compartments, each of which contains five or six short ones. The specimen measures about an inch and a half in length.

The specimen represented in Plate III, fig. 2, is a broken cast; but I am enabled to make out some characters in addition to those given by Geinitz. The original was of a conical form; slightly curved; with a deep cup, longitudinally furrowed on its inner surface; and several longitudinal plates of two lengths: the longest, about five in number, reached half way to the centre; the shortest are placed between the others, in sets of from one to four, making in all about sixteen plates. The cast shows, by means of a magnifier, that the lamellar interspaces were each furnished with two very finely-denticulated, slightly prominent ridges; but I have not been able to satisfy myself of the existence of marginal denticles on the plates. The Coral called by Count Münster *Anthophyllum venustum*, from the St. Kassian beds, offers a close resemblance to it.

Petraia profunda is a rare species. I have only succeeded in procuring two or three specimens from the Shelly Magnesian Limestone at Humbleton Quarry. Geinitz states its having been found in the lower Zechstein at Eisleben, Ilmenau, Gerbstedt, and between Hettstädt and Leimbach.

Sub-order Alcyonaria, Audouin and Milne Edwards, 1836.

Zoocorallia Octactinea, *Ehrenberg.*
Zoophytaria, *Blainville.*
Les Alcyoniens, *Audouin and Milne Edwards.*
Zoophyta Asteroida, *Johnston.*

The members of this order have several representatives on the coasts of Britain; but only one or two kinds, the Alcyonias (Dead Man's Hands), and Pennatulas (Sea-pens) are anywhere common: some others, as Gorgonias (Sea-fans) and Primnoas (Sea-shrubs), are but rarely met with; while the remainder, as the Tubiporas (Music-coral), Coralliums (Red Coral), and some others, are only to be found in foreign seas.

In the Alcyonarias, the body is usually of a cylindrical form; the mouth is

[1] Versteinerungen, p. 17.

generally encircled with eight broad, pectinated, prehensile tentacles; and the digestive cavity is often lined with a corresponding number of vertical membranous plaits, subserving the same purpose as their more numerous homologues in the Actinarias.

The only Permian Corals having any claim to be placed in this group, are those included in the four genera next to be described.

Genus *Calamopora*, Goldfuss.

Diagnosis.—"Stirps calcarea, e tubis prismaticis, parallelus, contiguis, divergentibus; tubi diaphragmatibus transversis (e siphone prolifero) intersepti, et poris lateralibus communicantes."[1] (Goldfuss.)

This genus, of which the type is the *Calamopora alveolaris*, Goldf., was formed for certain species of Corals, including the *Corallium Gothlandicum*, Lin., erroneously placed by Lamarck in his genus *Favosites*, which is typified by the *Madrepora truncata* of Esper. The tubes of all the species have their walls foraminated, and they are furnished interiorly with a number of transverse plates situated generally at regular distances from each other.

Calamoporas existed very abundantly as individuals, though not as species, during the earliest organic periods; but they do not appear to have lived subsequently to the Permian epoch.

Calamopora Mackrothii, *Geinitz*. Plate III, figs. 3, 4, 5, and 6.

(?) Calamopora spongites, *Goldfuss*. Petrefacta, p. 82, 1828.
(?) — — „ Germ. Transl. De la Beche, Geol. Man. p. 459, 1832; and 3d Eng. Ed. p. 572, 1833.
(?) — — „ Phillips, Enc. Met. vol. vi, p. 615, 1834.
(?) Tubulicladia spinigera, *Lonsdale*. De Verneuil, Bull. Soc. Géol. France, 2me série, vol. i, p. 23, 1844.
(?) — — „ Geol. Russ. vol. i, p. 221, 1845.
(?) Stenopora — „ Op. cit. vol. i, Appendix A, p. 632, pl. A, fig. 11, 1845.
Calamopora Mackrothii, *Geinitz*. Grundriss, p. 582, 1846.
Stenopora independens, *King*. Catalogue, p. 6, 1848.
— crassa, *Lonsdale*. Howse, T. N. F. C., vol. i, p. 260, 1848.
— Mackrothii, *Geinitz*. Versteinerungen, p. 17, pl. viii, fig. 10, 1848.
Coscinium dubium, *Geinitz*. Op. cit. p. 18, pl. vii, figs. 24-27, 1848.

Diagnosis.—A branching Calamopora: with numerous slender, round or polygonal, transversely-wrinkled tubes, rising perpendicularly in the centre of the branches, and afterwards suddenly curving out to the surface. *Interpolated or new tubes* numerous; originating on the outside of the old ones. *Margin of the apertures* with from five to eight spine-like tubercles.

[1] Petrefacta Germaniæ, vol. i, p. 77.

Considering that Mr. Lonsdale suspected this Coral to be the same as the Russian *Stenopora spinigera*,[1] it is to be regretted that the identity cannot as yet be satisfactorily made out. There appear to be some points of difference between them, which it may be as well to notice at present, such as the greater number of small interpolated tubes, and the large tubes suddenly bending out towards the surface, in the English Coral: it is probable, however, when better specimens of the Russian form are examined, that these differences will be found not to prevail, at least, to the extent alleged.

There can be little doubt that some of the specimens figured by Geinitz, in the 'Versteinerungen,' as *Stenopora Mackrothii* are specifically identical with the English Coral under consideration, particularly the one under figure 10, *a*, *b*, pl. vii; and this is strongly suspected to be the case with those figured and described under the name of *Coscinium dubium* (vide Op. cit. p. 19, pl. vii, figs. 24-7); but the specimens given under figures 8 and 9 of the same plate appear to belong to a different species, the one hereafter named *Stenopora columnaris*.

I formerly considered this Coral to belong to the genus *Stenopora;* but its mural foramina and transverse plates (vide Pl. III, fig. 6, *a*, *b*), as displayed in a beautiful specimen which I have lately procured, prove that it belongs to the genus *Calamopora* of Goldfuss. These plates are concave superiorly, and separated from each other by a space equal to the width of the tubes. The foramina generally run in perpendicular rows, the continuity of which is broken by the transverse plates.

The Coral appears to have been small and variable in form, sometimes simple, but generally with two, three, or more branches. The margin of the tube-apertures is furnished with from five to eight spine-like tubercles, apparently hollow. The interspaces between the apertures are generally small, through the close approximation of the tubes, or the interpolation of new ones. The tubes are for the most part long, running up the axis for a considerable extent, and afterwards suddenly curving out to the surface: new tubes spring from the outside of old ones: they are often transversely wrinkled or contracted, the contractions being parallel to the surface at whatever inclination the tubes are to the plane of the axis of the branches.

A large dendritic Coral, from the Carboniferous Limestone of Northumberland, occasionally measuring nine inches long, and apparently of this genus, has a structure agreeing with that of the present species. Its tubes are furnished with numerous transverse plates: their walls are foraminiferous; and they are marginated with tubercles; but the transverse plates do not extend to the centre of the tubes; generally little more than half way; the centre is consequently open, at least in the upper part of the tubes, but lower down it becomes closed.

De Koninck's *Favosites scabra* seems to be a closely allied form; and perhaps the Russian Coral which Kutorga has identified with the *Ceriopora milleporacea* of Goldfuss is the same species.

[1] Geology of Russia and the Ural Mountains, vol. i, Appendix A, p. 632.

Calamopora Mackrothii is rather a common Coral, being found at Tunstall Hill, Humbleton Quarry, Dalton-le-Dale, Ryhope Field-House Farm, and Whitley, in the Shelly Limestone. The German localities, according to Schlotheim and Geinitz, are Milbitz and Corbusen, in the lower Zechstein; and Glücksbrunn and Liebenstein, in the Zechstein-Dolomite.

Genus *Stenopora*, Lonsdale.

Coralliolites, *Schlotheim.*
Tubulicladia, *Lonsdale.*[1]

Diagnosis.—"A ramose, spherical, or amorphous tubular Polypidom; tubes polygonal or cylindrical, radiated from a centre or an imaginary axis, contracted at irregular distances, but in planes parallel to the surface of the specimen; tubular mouths closed at final periods of growth; ridge bounding the mouths, granulated or tuberculated; additional tubes interpolated."[2] (Lonsdale.)

This genus, founded on an Australian fossil Coral, the *Stenopora Tasmaniensis*, Lonsdale, is stated to be "essentially composed of simple tubes variously aggregated and radiating outwards. The mouth is round or oblong, and surrounded by projecting walls, having along the crest a row of tubercles. The mouth, originally oval, is gradually narrowed (δνευός) by a band projecting from the inner wall of the tube, and finally closed."[3]

In a specimen of *Stenopora Tasmaniensis* given me by Mr. Morris, the tubes are partitioned by transverse plates, with precisely the same varying character as those in the tubes of the Northumberland Carboniferous *Calamopora* already noticed; but there is no appearance of mural foramina.

Stenopora columnaris, *Schlotheim.* Plate III, figs. 7, 8, and 9.

Coralliolites columnaris, *Schlotheim.* Taschenbuch, p. 59, 1813.
— — ,, Akad. Münch., vol. vi, p. 23, pl. iii, fig. 10, 1820.
Stenopora incrustans, *King.* Catalogue, p. 6, 1848.
(?) Alveolites producti, *Geinitz.* Versteinerungen, p. 19, pl. vii, figs. 28-31, 1848.

Diagnosis.—An incrusting Stenopora. *Polypidoms* tubular, cylindrical, slightly wrinkled more or less transversely, and in close contact except towards their orifice, where they are a little reduced in diameter, leaving rather wide interspaces, which are often perforated with interpolated tubes. *Apertures* circular or slightly polygonal, with a tuberculated margin.

This species might easily be confounded with *Calamopora Mackrothii*, but, leaving out of view the want of transverse plates and its incrusting character, it has wider

[1] The name *Tubulicladia*, which is the earliest one, was rejected by Mr. Lonsdale for that of *Stenopora*.
[2] Strzelecki's Physical Description of New South Wales and Van Diemen's Land, p. 262, 1845.
[3] Lonsdale, in Darwin's 'Geological Observations on the Volcanic Islands,' Appendix, p. 161.

interspaces; the margin of its tube-apertures is more crowded with tubercles; and the apertures of both the full-grown and interpolated tubes have a more regular arrangement. I have not succeeded in discovering either surface or mural foramina; but I am not without a suspicion that they will yet be found.

Were I certain that this species possessed transverse plates, there would have been nothing of any weight remaining to prevent its being placed in the last genus; but having failed in discovering them, and looking to the simple character of its tubes, and its interpolated reproduction, I have been led to put it in *Stenopora*, though not without some doubt as to the propriety of the collocation: on the other hand, the pullulation of new tubes on the outside of the old ones (vide Plate III, fig. 8) opposes its being associated generically with the next species.

Although an incrusting Coral, I have a specimen of *Stenopora columnaris* coating some encrinal internodes, with a branch, apparently springing from its surface, and growing round an imaginary axis; but perhaps the case in point is nothing more than a *Calamopora Mackrothii* attached to the surface of a *Stenopora columnaris*.

This species is generally found covering fragments of the columns of *Cyathocrinus ramosus*, and filling up the cavities of shells. Schlotheim's figure, quoted in the list of synonyms, exhibits it under the former aspect. A specimen in my possession has grown on the large valve of a *Productus horridus*, which is similar to what Geinitz represents of a German Coral, herein doubtfully referred to the same species. I have seen other specimens incrusting the stems of *Thamniscus dubius*.

Except that it has wider interstitial spaces, and more interpolated tubes, *Stenopora columnaris* might be taken for De Koninck's *Alveolites irregularis*.

It occurs at Humbleton, Tunstall Hill, and Whitley; but is nowhere a common species. Geinitz's *Alveolites producti*, which may be the same Coral, is found at Corbusen, in Saxony.

Genus *Alveolites*, Lamarck, 1801.

Diagnosis.—"Polyparium lapideum, vel incrustans, vel in massam liberam, è tubulis plurimis concentricis invicem sese involventibus compositum. Tubulæ ex cellulis tubulosis, alveolatis, prismaticis, breviusculis, contiguis et parallelis formatæ, extus reticulatim concatenatæ."[1] (Lamarck.)

The tubes or cells of *Alveolites* are short, parallel, contiguous to each other, and of a prismatic shape, forming layers enveloping each other, and constituting elongated, sub-globular, hemispherical masses of varying sizes. Looking at the shortness of the tubes, Lamarck was induced to conclude that their polyp tenants had the body less elongated than those inhabiting the Tubipores or Music-corals.[2]

[1] Animaux sans Vertèbres, vol. ii, p. 285, 2d ed.

[2] Idem, p. 286.

Not being sufficiently acquainted with the typical species of this genus (*Alveolites escharoides*, from the environs of Dusseldorf,—query, Carboniferous or Devonian), I am not prepared to say how far it agrees with or differs from the apparently allied genus *Calamopora*. Reverting to *Alveolites*, probably the principal differences between it and the last consist in the shortness of the cells, their want of internal transverse plates, and their terminal mode of reproduction. These characters, keeping out of view the want of transverse plates, also appear to constitute the difference between the present genus and *Stenopora*.

Most of the Alveolites are yet only known in a fossil state. (Lamarck.)

ALVEOLITES BUCHIANA, *King*. Plate III, figs. 10, 11, and 12.

Diagnosis.—Tubes or cells adjoining, cylindrical, leaning, concavely arcuate ascendingly, alternately overlying each other, and slightly wrinkled more or less transversely. *Apertures* regularly arranged, circular, occasionally polygonal, margined by a circle of from twelve to fourteen small, closely-packed tubercles, which generally fill up the interspaces.

This pretty Coral, which is dedicated to one of our most profound palæontologists, differs from *Stenopora columnaris* in the more regular arrangement of its apertures, in the general absence of interpolated tubes, and in being composed of a single tubular layer. The interspaces are generally wide enough to admit of the presence of the tubercles belonging to two adjoining apertures (vide Pl. III, fig. 11): when wider, an interspace is here and there perceived, containing a small opening, which may belong either to additional interpolated tubes, or to old ones which have become decrepit. The apertures are regularly arranged, more so than those of *Stenopora columnaris*, and decidedly more uniform in their arrangement than the corresponding structures in *Calamopora Mackrothii*. The tubercles appear to be hollow, and connected with foramina, which a high magnifying power discloses on the interspaces when they (the tubercles) are abraded.

The only reason why this Coral has been separated generically from the last, is its mode of growth, a character which renders it doubtful whether *Alveolites* is the genus to which it really belongs. It seems advisable, however, to retain it in its present position, deferring all discussion on the matter until more is known of the structure of those palæozoic Corals which Lamarck placed in his fourth and fifth sections—"Polypiers à réseau" and "Polypiers foraminés."

Alveolites Buchiana is a scarce fossil, having only occurred to me once in the Shell-limestone at Humbleton-hill Quarry.

Aulopora, Goldfuss, 1830.

Millepora (dichotoma), *Linnæus.*
Tubiporites (serpens), *Schlotheim.*
Catenipora (axillaris), *Lamouroux.*

Diagnosis.—"Stirps calcarea, e tubulis obconicis, vacuis e latere proliferis, singulis ostiolis terminalibus exsertis."[1] (Goldfuss.)

Copying Milne Edwards, *Aulopora* may be described thus: "Tubes calcareous, with a round opening more or less projecting or elevated, originating laterally from each other, and forming by their union a creeping reticulated Coral, or a raised tubular mass."[2]

This genus, which Goldfuss established on the *Catenipora axillaris* of Lamouroux, consists of ramose, creeping, unilocular tubes; and has in its young stages, before it has become complicated in its ramifications, much of the aspect of *Alecto*, and some other repent, dendritic, tubular Bryozoic Corals. The latter, however, differ from the present genus in having chambered or celluliferous tubes, a difference that seems to warrant the placing of *Aulopora* among the Alcyonarias.

In my 'Catalogue' Bronn's genus *Stomatopora* is considered as synonymous with *Aulopora*, on the authority of what is stated in the 'Lethæa Geognostica,' p. 54; but I now suspect that it is only *Alecto* which stands in this position. I am not aware that any Auloporas have been found higher in the series of formations than the palæozoic.

Aulopora Voigtiana, *King*. Plate III, fig. 13.

Aulopora, n. s., *King*. De Verneuil, Bull. Soc. Géol. Fr., 2me série, vol. i, p. 24, 1844.
— — „ Geol. Rus., vol. i, p. 221, 1845.
Stomatopora (Aulopora) dichotoma, *Lamouroux*. King, Catalogue, p. 6, 1848.

Diagnosis.—*Stems and branches* slender, beaded, composed of a single series of flask-shaped *cellules*, which are narrow at their proximal end, and swelled at their distal extremity. *Branches* originating on the sides of the cellules near their distal extremity. Cellule-apertures . . . (?)

Aulopora Voigtiana agrees in appearance so closely with Lamouroux's *Alecto dichotoma*, that I was formerly led to believe in their identity; the stems and branches in the latter species, however, are too uniform in width to admit of the identification. Specimens occasionally occur decidedly more branched than the one which is figured.

I have not yet been able to ascertain whether this species is unilocular or chambered;

[1] Petrefacta, vol. i, p. 82.
[2] Lamarck, Animaux sans Vertèbres, vol. ii, p. 323, 2d ed.

its generic collocation is therefore still a matter for further consideration; and on the same ground it is even doubtful whether it should be considered an Alcyonaria or a Bryozoon. It is named after M. Voigt, whose 'Practische Gebirgskunde' contains some account of the Permian beds of Germany.

The specimen figured is attached to the exterior of a *Productus horridus* found in the Shell-limestone at Humbleton Quarry, where it is rare.

Sub-class Ciliobrachiata, Farre.

Polyzoa, *J. V. Thompson.*
Bryozoa, *Ehrenberg.*
Zoophyta Ascidoida, *Johnston.*
Polypes Tuniciens, *Milne Edwards.*

As previously stated, this group of Zoophytes does not appear to be divisible into orders like the last sub-class, notwithstanding the attempts which have been made to divide it by some naturalists. The divisions *Infundibulata* and *Hippocrepia* proposed by M. Gervais, as based chiefly on difference of habitat, whether marine or fresh-water, appear so divested of the necessary structural individuality, and of so little value compared with the orders already noticed, that in place of adopting them, it seems a much safer plan to regard the Ciliobrachiates as resolvable into only one order, for which Ehrenberg's name *Bryozoa* may be very conveniently retained. In this case the names of M. Gervais may be advantageously used to distinguish groups of a lower value.

The sub-class *Ciliobrachiata* comprises both marine and fresh-water productions. The very minute Cristatellas and Plumatellas inhabiting ponds and lakes are of the latter kind; while the Flustras (Sea-mats), Escharas, Elasmoporas (Lace-coral), and several others, represent the marine section.

As some of the members of this sub-class form a highly interesting group of Permian Zoophytes, I have been induced to give a short description of the polyps inhabiting similar productions of the present seas. Referring to Plates II, IV, and V, certain figures will be observed representing highly magnified parts of *Fenestella* and other allied genera. These figures exhibit the stems, branches, and other parts, with a number of circular openings (vide Pl. II, figs. 9, 10, and 11; Pl. IV, fig. 5; Pl. V, figs. 3, 9, 11, 12, &c.), which in the originals are so minute as to require a magnifier to render them visible. Every opening is the entrance to a minute cell formerly tenanted by a microscopic polyp, thousands of which constructed and cotenanted such a Coral as is represented in Plate III, fig. 14. In giving a description of an existing ciliobrachiate polyp and its cell, it is believed that it will serve to illustrate the Corals hereafter to be described.

The polyp is generally of the form of an elongated sac, which is protected for a considerable extent inferiorly by a covering of a horny nature in *Flustra*, and of

calcareous matter in *Eschara.* It is this portion which constitutes aggregately the cells or polypidoms so beautifully preserved in the fossils, and remaining in the recent forms just named after the death of their tiny occupants. From my own observations on *Flustra*, *Escharina,* and some other allied genera, I am led to believe, that after the deposition of the base of the cell, the lateral perpendicular walls are first erected, and when they have been elevated to the proper height, the front wall is gradually formed, commencing with the lower or proximal part of the cell, and finishing with the aperture at the opposite or distal extremity. The entire substance of the cell is minutely porous; and in addition, the front wall is variously ornamented with large openings or foramina:[1] it is also furnished, in certain genera, with some curious complicated structures (birds' head and other processes), the economy of which is not at all understood. Reverting to the polyp; the upper portionof the sac, which is generally a soft, retractile, and transparent membrane, is crowned with, in many cases, a beautiful campanuliform appendage, consisting of rather long, delicate, tubular, ciliated tentacles, varying in number according to genera and species: in a species of *Escharina* now under examination, there are about twenty-four tentacles. Within the tentacular cup is situated the mouth or oral aperture, which, according to the researches of Farre and other observers, leads into a long membranous gullet, at first considerably dilated and puckered, so as to resemble the branchial chamber of the Ascidians, and probably subserving respiration as well as deglutition (Milne Edwards). For some distance lower down, the gullet is contracted, ending in a gizzard of a rounded form, internally beset with minute teeth, and succeeded by a pouch-shaped stomach terminating at a short distance from the base of the cell. From the upper part of the stomach a narrow intestine ascends alongside of the gullet, terminating near the oral aperture, where it forms the cloacal outlet. The superior or soft portion of the sac can be withdrawn into the inferior solid portion or cell in the same manner as inverting the finger of a glove. When in this state, the polyp is protected by a corneous moveable lid or valvular fold of the integument fitting into the aperture, and occasionally by a girdle of setæ closely converging over the same opening. The gullet and intestine are folded somewhat in the form of a siphon. The protrusion and retraction of the soft portion of the polyp, and the various organs connected with it, are effected by means of muscles conveniently situated within the sac. When the polyp protrudes itself, the "bundle of setæ first rises out of the apex of the cell, and is followed by the rest of the flexible integument; the tentacula next pass up between the setæ, and separate them; the folds of the œsophagus and intestine are straightened, and when the act of protrusion is completed, the crown of tentacles expands, and their cilia commence vibrating."[2]

[1] The foramina are distinctly seen on the non-celluliferous surface of the Corals represented in Plate II, fig. 16; Pl. V, fig. 8.

[2] Owen, Lectures on the Comparative Anatomy and Physiology of the Invertebrate Animals, pp. 96-7.

Milne Edwards gives it as his opinion that few Bryozoons or Ciliobrachiate Corals existed during the early geological periods; late researches, however, show that they coexisted with the earliest Actinarians; and they seem to have been considerably more abundant than the latter during the Permian epoch.

Family Fenestellidæ, King,[1] 1849.

The establishing of this group is obviously called for, now that there are so many reticulated genera of Palæozoic Corals possessing a structure which prevents their being placed in any of the families already formed. *Elasmoporidæ* appear to have the closest relationship to *Fenestellidæ;* but Mr. Lonsdale has shown such a marked difference between their respective generic types, that a separation to the extent proposed seems to be strongly warranted. Considering *Fenestella* as the type of the family, it is proposed to include in it all those reticulated genera agreeing with this genus, in having the cellules planted on a basal plate composed of vertical capillary tubes, as first discovered by the author just noticed. Besides *Fenestella* this family embraces the *Ptylopora* and *Polypora* of M'Coy, also the genera *Synocladia* and *Phyllopora*, shortly to be introduced.

Genus *Fenestella*, Miller.

Ceratophytes (retiformis), *Schlotheim.*
Gorgonia (infundibuliformis), *Goldfuss.*
Retepora (flustracea), *Phillips.*

Diagnosis.—"A ramose, cellular, calcareous polypidom; cells variously distributed on one side of the branches, with or without dividing ridges: branches connected by transverse or oblique processes cellular or not, forming, generally, expansions or funnel-shaped bodies: the latter with the cellular surface sometimes on the inner, sometimes on the outer side; cells cylindrical, obliquely arranged, overlying, mouths inclined outwards, more or less distant; interior of mature specimens, a layer of vertical capillary tubuli; reverse side of young specimens, the layer of tubuli of mature specimens, a crust perforated by minute pores; in aged specimens both cellular and reverse surfaces greatly thickened, all external ribs or sculpturing obliterated, and oral apertures more or less contracted; a row of foramina or chambers between the parallelly-disposed cells, or a small shallow cavity over the mouth in species with cells in quincunx."[2] (Lonsdale.)

Professor Phillips states, that the late Mr. Miller of Bristol, many years ago,

[1] Vide Annals and Mag. of Nat. Hist., 2d series, vol. iii, p. 388.

[2] Geology of Russia, vol. i, Appendix A, p. 629.

suggested to him the propriety of establishing a new genus for some of the reticulated Corals allied to *Retepora;* and on mentioning this to Mr. Lonsdale, he, at once, adopted the suggestion, and named a species *Fenestella Milleri*,[1] in his notice on Fossil Corals, appended to Sir Roderick I. Murchison's 'Silurian System.' Since then, Mr. Lonsdale has most successfully worked out the genus in Darwin's work already referred to, and in the "Appendix A" of the great work on 'Russia and the Ural Mountains,' by Sir Roderick I. Murchison, Count Keyserling, and M. E. de Verneuil.

Believing that the genus *Fenestella*, as constructed by Mr. Lonsdale, requires subdividing, it is suggested, that the diagnosis just given be modified as regard the arrangement of the cellules, and the character of the connecting bars. I would therefore propose the following alteration.

A ramose, cellular, calcareous polypidom: cellules longitudinally distributed on one side of the branches, in two or more linear series, the series separated from each other by a dividing ridge: stems or ribs connected by transverse non-celluliferous processes; forming generally expansions or funnel-shaped bodies, &c. &c.

By adopting this alteration we keep together a large number of Palæozoic Corals having a well-defined character, such as *Fenestella antiqua*, Lonsd., *F. crassa*, M'Coy, and *F. flabellata*, Phill., and divested of the species constituting M'Coy's *Polypora* and *Ptylopora*, and those forming the two succeeding genera; at the same time *Fenestella antiqua* is still retained as the type of the genus.

FENESTELLA RETIFORMIS, *Schlotheim*. Pl. II, figs. 8, 8*a*, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19.

KORALLOPHITEN, KERATOPHYTEN, &c., *Schl.* Taschenbuch, pp. 55, 59, 1813.
(?) RETICULATED MARINE PRODUCTION RESEMBLING THE GENUS FLUSTRA, *Winch.* Trans. Geol. Soc. Lond. 1st series, vol. iv, p. 10. 1817.
KERATOPHYTES RETIFORMIS, *Schl.* Akad. Münch., vol. vi, pp. 17-20, pl. i, figs. 1, 2, 1820.
ESCHARITES — „ Petrefact. pp. 342-3, 1820.
(?) RETICULATED MARINE PRODUCTION, *Winch.* Conybeare and Phillips, p. 305, 1822.
ESCHARITES RETIFORMIS, *Schl.* Boué, Edin. Phil. Journ. vol. xii, p. 144, 1825.
(?) CORALLOID RESEMBLING GORGONIA FLABELLUM, *Hogg.* Nat. Hist. Stockton, p. 78, 1827.
GORGONIA INFUNDIBULIFORMIS, *Goldfuss.* Petrefacta, p. 20, pl. x, fig. 1*a*; and pp. 98, 99, pl. xxxvi, fig. 2 *b*, *c*, 1828. (?)
— ANTIQUA, *Goldfuss.* Op. cit., p. 99, pl. xxxvi, fig. 3 *b*, 1828. (?)
RETEPORA FLUSTRACEA, *Phillips.* Trans. Geol. Soc. Lond. 2d series, vol. iii, p. 129, pl. xii, fig. 8, 1829.
— — „ De la Beche, Geol. Man. p. 385, 1831; Op. cit., Germ. Trans. p. 459, 1832; and 3d English Edition, p. 572, 1833.

[1] Palæozoic Fossils, p. 22.

GORGONIA INFUNDIBULIFORMIS, *Goldf.* Op. cit., Germ. Trans., p. 459, 1832; and 3d English Edition, p. 572, 1833.

— ANTIQUA, *Goldf.* Op. cit., Germ. Trans., p. 459, 1832; and 3d English Edition, p. 572, 1833.

RETEPORA FLUSTRACEA, *Phillips.* Encyc. Metr., vol. vi, p. 615, pl. iii, fig. 8, 1834.

GORGONIA INFUNDIBULIFORMIS, *Goldf.* Phillips, Op. cit.

— ANTIQUA, *Goldf.* Phillips, Op. cit.

— INFUNDIBULIFORMIS, *Goldf.* Bronn, Lethæa Geogn. p. 47, pl. v, fig. 13 *a*, *b*, 1835.

— RETIFORMIS, *Schl.* Quenstedt, Wiegmann's Archiv, p. 89, 1835.

RETEPORA FLUSTRACEA, *Phillips.* Thomson, Min. Geol., vol. ii, p. 294, 1836.

— — ,, Phillips, Lardner's Cycl. Geology, vol. i, p. 190, 1837.

GORGONIA RETIFORMIS, *Schl.* Morris, Catalogue, p. 38, 1843.

— — ,, Geinitz, Gæa von Sachsen, p. 98, 1843.

— ANTIQUA ,, Op. cit.

FENESTELLA ANTIQUA, ,, Bull. Soc. Géol. Fr., 2me série, vol. i, p. 24, 1844.

— FLUSTRACEA, *Phillips.* Idem.

— INFUNDIBULIFORMIS, *Goldf.* Idem.

— RETIFORMIS, *Schl.* Idem.

LAST FOUR SYNONYMS. Geol. Russ., vol. i, p. 221, 1845.

FENESTELLA FLUSTRACEA, *Phillips.* Tennant, Strat. List, p. 88, 1847.

— RETIFORMIS, *Schl.* King, Catalogue, p. 6, 1848.

— FLUSTRACEA, *Phillips.* Howse, T. N. F. C., vol. i, p. 261, 1848.

— ANTIQUA, *Goldf.* Idem.

— RETIFORMIS, *Schl.* Idem.

— — ,, Geinitz, Versteiner., p. 17, pl. vii, figs. 11-13, 1848.

— ANTIQUA ,, Geinitz, Op. cit.

Diagnosis.—Fronds or foliations variously folded, more or less convoluted, and generally funnel-shaped. *Stems or ribs* slender, more or less bifurcating. *Cellules* small, bi-serially arranged; the series separated from each other by a narrow tuberculated ridge. *Connecting processes* slender, and generally short. *Meshes* more or less oval. *Non-celluliferous surface* marked with fine straight longitudinal striæ. *Both surfaces of the stems* minutely foraminated.[1]

Fenestella retiformis is a variable Coral; and, in consequence, some have been led to divide it into two or more species; but I feel satisfied, from examining a large suite of specimens, that the observed differences are not sufficiently persistent to be considered as specific, being due merely to difference of age or incidental causes.

The stems or ribs, in the young state, show the dividing ridge slightly prominent; when more advanced, it is strongly raised and tuberculated. These and another modification, all of which are occasionally displayed on one specimen, are represented in Plate II, figs. 9, 10, and 12. In dwarfed specimens the stems are oftener divided

[1] The following is the diagnosis given by Goldfuss: "Gorgonia undulata, infundibuliformis, subtilissime reticulata, ramulis teretibus, cortice crassiuscula osculis creberrimis tuberculata." (Petrefacta Germaniæ, vol. i, p. 99.)

than usual, and their lower part, on the celluliferous surface, is strongly angulated through the prominency of the dividing ridge, and the close proximity of the tubercles; while higher up they possess the usual characters. Similar differences obtain with the meshes, the form of which depends chiefly on the distance of the stems from each other, being circular in one specimen, oval in another, oblong in this, and linear in that. The fossil represented by Goldfuss in the 'Petrefacta Germaniæ,' pl. xxxvi, fig. 2 *b*, *c*, is a rare condition for this species. I have been fortunate, however, in obtaining a specimen resembling it, showing the tubercles with an aperture at the apex, as represented in Plate II, fig. 11. Never having been able to find any internal casts of these appendages, so frequent as regards the cellules, I am inclined to think that they remained closed until a late period of their growth. Mr. Lonsdale, referring to Goldfuss's figure, simply designates them "abraded vesicles."[1] Why may they not be considered gemmuliferous vesicles, which have become ruptured through the discharge of their contents? M'Coy's *Fenestella carinata*, and some other species, display similar open cellules.[2]

This Coral sometimes attains a large size: the frond of my largest specimen measures eight inches in width. The under side or non-celluliferous face is occasionally seen with root-like processes, apparently hollow, from $\frac{1}{8}$ to $\frac{1}{4}$ of an inch in length, striking off from the stems (vide Plate II, figs. 18 and 19). From what is displayed in a specimen before me, I am inclined to think that in many cases all the fronds of one Coral possess these processes, and that they served, not only as supports to the fronds, but as stays to keep them separated from each other. Specimens are sometimes so completely folded, that it is difficult to abandon the idea of its being the outer surface of the frond, which is celluliferous. Is not the specimen represented by Geinitz, in his 'Versteinerungen,' pl. vii, fig. 15, in this condition?

Mr. Lonsdale, in showing that *Fenestella* has no relation to *Gorgonia*, the genus in which Goldfuss and others have placed the Permian Corals, states, that "beneath the thick series of obliquely-overlying cylindrical cells, limited to one side of the Coral, there is no axis formed of concentric bands, yet distinct from the crust," as in *Gorgonia*, "but a parallel layer of vertical, capillary tubes, the walls of which differ not apparently from those of the cells. In the young state this layer constitutes the outer surface of the non-cellular side."[3] In *Fenestella retiformis* the vertical capillary tubes are sometimes finely displayed, when they are seen to be straight, and crowded with minute foramina, as shown in the magnified representation in Plate II, fig. 17. According to Mr. Lonsdale, the intermediate layer of vertical capillary tubes is totally wanting in *Retepora* (*Elasmopora*), proving that the species under consideration does not belong to this genus, as was formerly supposed.

[1] Geology of Russia, &c., vol. i, Appendix A, p. 630.

[2] Synopsis of the Carboniferous Fossils of Ireland, pl. xxviii, fig. 12; pl. xxix, figs. 1, 2.

[3] Geology of Russia, vol. i, Appendix A, p. 627.

The Russian Coral which Mr. Lonsdale has identified with *Fenestella retiformis* appears to be a distinct species, that is, if the cellules on its branches are really triserially arranged, and the connecting processes "occasionally cellular;" as I have never yet found any British specimens displaying a tendency to become so far modified. Several specimens which I collected at Könitz differ in no respect from a variety, occurring at Humbleton, with frequently dividing branches, and the cellules rather wider apart than usual. Quenstedt appears to have been the first to identify the British Coral with Schlotheim's *Keratophytes retiformis*.[1]

This species is rather abundant in the Magnesian Limestone at Humbleton Quarry, Ryhope Field-house Farm, Dalton-le-Dale, and Hylton North-Farm; it occurs sparingly at Tunstall Hill and Castle Eden Dene. Mr. Hogg probably alluded to this species, when noticing the occurrence in the last locality of a "coralloid resembling *Gorgonia flabellum*." At Tynemouth I procured a small specimen imbedded in the Breccia. Professor Sedgwick records a specimen which he found "in the beds of Blue Limestone at Nosterfield, near Tanfield."[2] It occurs at several localities in Germany. The first published specimen, which is noticed by Schlotheim in the 'Taschenbuch,' p. 55, was found in the Kupferschiefer of Schmerbach. The other German localities, as recorded by Von Dechen, Geinitz, Goldfuss, and Schlotheim, are Altenburg, Könitz, Liebenstein, and Glücksbrunn, in the Zechstein-Dolomite; Corbusen and Milbitz in the Lower Zechstein.

Genus *Synocladia*, King, 1849.

Retepora (virgulacea), *Phillips.*
Gorgonia (dubia = virgulacea), *Morris.*
Fenestella (virgulacea), *Lonsdale.*

Diagnosis.—"A foliaceous or frondiferous infundibuliform Fenestellidia. *Fronds* consisting of numerous connected stems or ribs. *Stems* bifurcating; radiating from a small root; running parallel to, and at a short distance from each other, on one plane; and giving off bilaterally numerous short, simple branches, of which opposite pairs conjoin midway between the stems arcuately or at an ascending angle. *Branches* occasionally modified into stems. *Cellules* on the inner or upper surface of the fronds; on both stems and branches; imbricated; and distributed in longitudinal series. *Series of cellules* separated from each other by a dividing ridge."[3] (?) *Gemmuliferous vesicles* on the dividing ridges.

Type, *Retepora virgulacea*, Phillips.

Synocladia differs from all other Fenestellidias in the character of the branches or

[1] Wiegmann's Archiv, 1835, p. 91.

[2] Trans. Geol. Soc. London, 2d series, vol. iii, p. 120.

[3] Vide Annals and Magazine of Natural History, 2d series, vol. iii, pp. 388, 389.

connecting processes, which, on account of their arched or angulated form, their being celluliferous, and their occasionally becoming modified into stems, remove it from the genus (*Fenestella*), in which it has hitherto been placed. It differs from *Polypora*, M'Coy, equally as regards the connecting processes; also in the serial arrangement of the cellules. I am not aware of the existence of any other species but the one following.

SYNOCLADIA VIRGULACEA, *Phillips.* Plate III, fig. 14; Plate IV, figs. 1, 2, 3, 4, 5, 6, 7, and 8.

(?) RETICULATED ALCYONITE, *Winch.* Trans. Geol. Soc. Lond., 1st series, vol. iv, p. 10, 1817.
(?) — — „ Conybeare and Phillips, p. 305, 1822.
RETEPORA VIRGULACEA, *Phillips.* Trans. Geol, Soc. Lond., 2d series, vol. iii, p. 120, pl. xii, fig. 6, 1829.
— — „ De la Beche, Geol. Man., p. 385, 1831; Germ. Transl., p. 459, 1832; and 3d Eng. Ed., p. 572, 1833.
— — „ Encyc. Met., vol. vi, p. 615, pl. iii, fig. 2, 1834.
— — „ Thomson, Min. Geol., vol. ii, p. 294, 1836.
GORGONIA DUBIA, *Schlotheim.* Morris, Catalogue, p. 38, 1843.
FENESTELLA VIRGULACEA, *Phillips.* Bull Soc. Géol. France, 2me série, vol. i, p. 25, 1844.
— — „ Geol. Russ., vol. i, p. 221, 1845.
— — „ Tennant, Strat. List, p. 88, 1847.
— — „ King, Catalogue, p. 6, 1848.
— — „ Howse, T. N. F. C., vol. i, p. 263, 1848.

Diagnosis.—A funnel-shaped, multi-foliaceous Synocladia, springing from a small root. *Foliations* more or less folded and convoluted. *Stems* somewhat strong, often dividing. *Cellules* in from three to five furrows. *Dividing ridges* with the (?) gemmuliferous vesicles alternating with the cellule-apertures. *Branches or connecting processes* in general angulated midway between two adjoining stems; furnished, for the most part, with two rows of cellules; and occasionally becoming modified into stems or ribs.

This beautiful Coral is often found attaining a large size, but rarely in a complete state, owing to its foliations readily separating from each other: what is generally seen is only one frond belonging to a single individual. It varies somewhat in a few of its characters; as in the width of the stem-interstices, the greater or less divarication of the stems producing a corresponding change in the meshes: when the stems are close to each other, the connecting branches or processes lose their normal character, passing across the interspaces obliquely or horizontally; and where they are much separated from each other, the branches become converted into stems. When the branches, forming a consecutive set, are modified in this manner, they offer a striking

resemblance to the genus *Ptylopora* of M'Coy. These modifications are represented in Plate IV, fig. 5. The bifurcation of the stems appears to be caused by the addition of one or more longitudinal rows of cellules. A stem goes on increasing in width for a while, through the interposition and gradual development of a new row of cellules; after which it divides: both divisions then increase in length, each one afterwards dividing in the manner described. The cellules have a raised margin surrounding their aperture; and their cast shows them to be curved, overlying each other, and slightly contracted at their upper part (vide diagram under figure 6, Plate IV). The so-called gemmuliferous vesicles alternate with the adjoining cellule-apertures: they often leave their impression in the form of a pit intervening between the rows of impressed cellule-apertures, when the celluliferous surface of the fossil is in the state of an impression, as exhibited in figure 4, Plate IV; occasionally, however, a specimen occurs with the celluliferous surface itself exhibited, as in figure 5, Plate IV, in which case the (?) gemmuliferous vesicles are seen to be tubercular, and open at the summit. Sometimes specimens are found furnished with simple root-like processes on the under side of the fronds (vide Plate IV, figs, 7 and 8), similar to those already noticed when describing *Fenestella retiformis*.

Synocladia virgulacea is rather a common species in some localities, as at Humbleton Quarry, Ryhope Field-house Farm, Dalton-le-Dale, and Hylton North-Farm. It is less common at Tunstall Hill, and very rare at Whitley. In all these localities it is found in the Shelly Magnesian Limestone. I found a small specimen in Breccia at Tynemouth Cliff. It does not appear to have been noticed either in Germany or Russia.

Genus *Phyllopora*, King, 1849.

Gorgonia (Ehrenbergi), *Geinitz*.
Fenestella (Permiana = Ehrenbergi), *King*.

Diagnosis.—"A Fenestellidia consisting of infundibuliform, folded, perforated fronds or foliaceous expansions. *Cellules* on the whole of the outer or under surface of the fronds; and planted more or less approximating to a position at right angles to the plane of the capillary-tubular basal plate. *Cellule-apertures* with plain margins, and parallel to the surface of the fronds."[1]

Type, *Gorgonia Ehrenbergi*, Geinitz.

In order that the present group be properly appreciated, it has been deemed necessary to make a few observations on the genus *Retepora*, and another one lately published in the 'Annals and Magazine of Natural History' under the name of *Elasmopora*. Lamarck founded his *Retepora* on three or more species of very dissimilar structure, some of which have already been made typical of other genera; the type,

[1] Annals of Natural History, 2d series, vol. iii, p. 389.

however, of the Lamarckian genus is the first-described species, the *Millepora reticulata* of Linnæus, an irregularly-reticulated frondiferous Coral, having its inner or upper surface exceedingly verrucose through the irregular prominency of its tubes. Lamouroux and Blainville, observing the striking difference between the *Retepora reticulata*, as it may now be termed, and the next species which Lamarck noticed, namely, the *Millepora cellulosa* of Linnæus, took the opportunity of placing the latter as the type of *Retepora*, making, at the same time, a new genus for the former—Lamouroux calling it *Krusensternia*, and Blainville, *Frondipora*. This is a proceeding which cannot be too much discountenanced, as it involves scientific nomenclature in the greatest possible confusion, and without any prospect of its being ended. It is chiefly to a similar proceeding on the part of other writers, that so many difficulties beset the study of most of the genera of Palæozoic Corals. The plan which I purpose adhering to throughout this Monograph is to consider the first species described under the head of any genus to be the type of it, unless otherwise stated; as I feel persuaded that this will enable me to treat authors with every fairness due to them, and at the same time it will dispose of many such difficulties as those complained of.

It may now be allowed me to transcribe a portion of what I have already published in connexion with the genus founded on the *Millepora cellulosa*.

"*Family* Elasmoporidæ, King, 1849.

"This group agrees with *Escharidæ* in the structure of its polypidoms or cellules, but differs therefrom in being uni-lamello-celluliferous, and reticulated. Only the following genus is known to the writer.

"Genus *Elasmopora*, King, 1849.

"*Diagnosis.*—The typical Elasmoporidia, consisting of infundibuliform, folded, perforated fronds or foliaceous expansions, which are entirely celluliferous; the cellules opening on their inner or upper surface. *Cellules* arranged alternately, and running more or less parallel to the plane of the fronds; their front and dorsal walls forming the two faces of the fronds. *Cellule-apertures* approximating more or less to a position at right angles to the plane of the fronds, and furnished with tubular and other processes on their inferior or projecting margin. *Gemmuliferous vesicles* overlying the cellule-apertures. *Both surfaces of the fronds* foraminated. *Outer or under surface of the fronds* marked with distant waved lines, forming the boundaries of the cellules.

"Type, *Millepora cellulosa*, Linnæus, a species occurring in the Mediterranean. An allied species (*Elasmopora Beaniana*, King) inhabits the British seas."[1]

[1] Annals and Magazine of Natural History, 2d series, vol. iii, p. 390.

Elasmopora is nearly related to *Eschara* in the position of the cellules relatively to the plane of the frond, and in the structure of the same parts; but it differs from the latter in the fronds being perforated, and composed of only one plate of cellules.

Reverting to *Phyllopora;* this genus differs from *Fenestella*, *Polypora*, and *Synocladia*, in its fronds not being formed of radiating or parallel stems or ribs; from the first two, in the want of non-celluliferous connecting bars; and from the first and the last,[1] in the nearly vertical position of its cellules in relation to the plane of the fronds; while the plain-margined cell-apertures of all these genera, and the bi-structural character of their fronds, consisting on the one side of cellules or polypidoms, and on the other of capillary tubes, seem strongly to favour their intimate alliance, and their belonging to one and the same family.

With regard to *Elasmopora*, there is an unapproachable difference between it and *Phyllopora*, as will be seen by placing collaterally the principal characters of each.

Phyllopora, (vide Pl. V, figs. 3, 4, 6.)	*Elasmopora.*
Outer or under surface or side of the fronds celluliferous.	*Inner* or upper surface or side of the fronds celluliferous.
Fronds composed of *two laminæ* of different structures. Inner lamina of capillary tubes (fig. 4 *a*, and fig. 6 *b*); outer lamina of cellules or polypidoms placed nearly at right angles to the latter (fig. 3 *b*, and fig. 6 *a*).	Fronds composed of *one lamina* consisting simply of cellules or polypidoms.
Substance of celluliferous side consists of *cellule-interstices* or dissepiments (fig. 3 *c*, and fig. 6 *c*).	Substance of celluliferous side consists of the *front wall* of the cellules.
Cellules nearly at *right angles* to the plane of the fronds.	Cellules *nearly parallel* to the plane of the fronds.
Cellule-apertures *parallel* to the plane of the fronds.	Cellule-apertures more or less at *right angles* to the plane of the fronds.
Margin of the apertures *plain*.	Margin of the apertures furnished with *tubular and other processes*.

I suspect that *Phyllopora* will eventually embrace several species of Palæozoic Corals; but until more is known of their structure, it seems preferable to wait rather than make generic identifications which may eventually prove incorrect. Is the so-called *Retepora prisca*, represented in Phillips's 'Palæozoic Fossils,' pl. xiii, fig. 37, furnished with cellules on the outer surface? Perhaps I may be permitted to request a close examination of the curious fossil M'Coy has described in Dr. Griffith's 'Synopsis,' under the name of *Retepora undata* (pl. xxix, fig. 11), with the view of ascertaining whether or not it belongs to this genus.

[1] Being unacquainted with the internal structure of *Polypora*, I cannot speak as to the position of its cellules.

PHYLLOPORA EHRENBERGI, *Geinitz*. Pl. V, figs. 1, 2, 3, 4, 5, 6.

GORGONIA EHRENBERGI, *Geinitz*. Grundriss, p. 585, pl. xxiii *a*, fig. 12, 1846.
FENESTELLA PERMIANA, *King*. Catalogue, p. 6, 1848.
RETEPORA LONSDALII, *Howse*. T. N. F. C. vol. i, p. 263, 1848.
FENESTELLA EHRENBERGI, *Geinitz*. Versteiner., p. 18, pl. vii, figs. 16-18, 1848.

Diagnosis.—Foliations infundibuliform: generally (?) not much folded. *Meshes* oval: a little wider than the interstices: in general arranged in linear series longitudinally; and alternately in the opposite direction. *Cellules* slightly inclined upwards: from two to three on an interstice: with an oval or circular aperture, and a polygonal base. *Non-celluliferous face* marked with fine, waved, longitudinal striæ. *Capillary tubes* flexuous.

This beautiful Coral, first discovered by Geinitz, is remarkable for consisting *apparently* of a single funnel-shaped foliation, strikingly conical when young (vide Pl. V, fig. 2), but afterwards becoming more expanded. Besides the figure just referred to, Dr. Geinitz has given a similar one representing a specimen equally as conical in form, and a larger one showing the same character; and Mr. G. Tate collected a beautiful specimen at Tunstall Hill, of a nearly cylindrical form, and in a very unusual state of preservation, showing its inner or non-celluliferous surface. It must not be omitted, however, that I suspect, when we are more acquainted with this species, it will be found to consist of a number of foliations, as in the *Fenestellidæ* already described. Allusion has already been made to the nearly vertical position of the cellules in relation to the plane of the foliations, a character so marked, that I have been induced to regard it as of generic importance. Figure 6 of Plate V represents a magnified view of the cellules; showing how strikingly their position contrasts with the curving and imbricated character of the cellules of *Synocladia virgulacea*.

Phyllopora Ehrenbergi appears to be a scarce Coral both in England and Germany. It occurs very rarely at Silksworth, Tunstall Hill, and Humbleton Quarry, in the Magnesian Limestone. Geinitz mentions its occurrence in the Lower Zechstein at Corbusen and Milbitz; and in the Zechstein-Dolomite at Glücksbrunn.

Family THAMNISCIDÆ, *King*. 1849.[1]

This group comprises certain shrub-like genera of Palæozoic ciliobrachiate Corals, possessing the bi-structural and polypidomial characters of Fenestellidias, and having very much the appearance of recent Horneras. It embraces the two following genera, one of which (*Thamniscus*) is the type, and apparently Mr. M'Coy's *Ichthyorachis*. All the known constituent genera are readily distinguished from Fenestellidias by having free stems and branches.

[1] Annals and Magazine of Natural History, 2d series, vol. iii, p. 389.

Genus *Thamniscus*, King, 1849.

Diagnosis.—"The typical Thamniscidia. *Stems* frequently and irregularly bifurcating more or less on one plane: celluliferous on the side overlooking the imaginary axis of the Coral. *Cellules* imbricated and arranged in quincunx. *Gemmuliferous vesicles* overlying the cellule-apertures."[1]

Type, *Ceratophytes dubius*, Schlotheim.

I formerly placed the type of this genus in Lamouroux's *Hornera*; but it is evident from Mr. Lonsdale's observations that this was an erroneous collocation.[2] At the time my 'Catalogue' was published, I had not made up my mind how this species, and the one following it, should be disposed of generically, though I felt persuaded that they could not be included in any of the reticulated genera then established. I was therefore induced to adopt provisionally the name which Schlotheim had given to them, under the erroneous impression, probably, that they were of a horny and flexible nature, and consequently true *Ceratophytes* as contradistinguished from the *Lithophytes* or calcareous Corals.

The principal distinctive characters of *Thamniscus*, compared with other allied genera, consist in the frequent and irregular terminal bifurcation of the stems, and in the gemmuliferous vesicles overlying the cellule-apertures.

Probably the *Fenestella intertexta* of Captain Portlock,[3] is a congeneric species.

Thamniscus dubius, *Schlotheim*. Plate V, figs. 7, 8, 9, 10, 11, 12.

Encrinites ramosus, in pars, *Schl.* Münch. Akad., vol. vi, pp. 20-24, pl. ii, fig. 4; pl. iv, figs. 16, 17, 1820.
Keratophytes dubius, *Schl.* Petrefacten, p. 341, 1820.
Ceratophytes — ,, Boué, Edin. Phil. Journ., vol. xii, p. 144, 1825.
Gorgonia dubia ,, Goldfuss, Petref., pp. 18, 19, pl. vii, fig. 1 *a*, *b*, *c*, 1826.
Unknown Coralline Body, *Sedgwick*. Trans. Geol. Soc. Lond., 2d series, vol. iii, pl. xii, fig. 5, 1829.
Gorgonia dubia, *Schl.* Germ. Transl. Geol. Man., p. 459, 1832.
— — ,, Quenstedt, Wiegmann's Archiv, p. 91, 1835.
— anceps et G. dubia, *Schl.* Morris, Catalogue, p. 38, 1843.
— dubia, ,, Geinitz, Gæa von Sachsen, p. 98, 1843.
Fenestella (Hornera ?) ramosa, *King*. Bull. Soc. Géol. Fr., 2me série, vol. i, p. 23, 1844.
— (?) dubia, *Schl.* Idem, p. 24.
— (?) — ,, Geol. Russ., vol. i, p. 221, 1845.

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[1] Annals and Magazine of Natural History, 2d series, vol. iii, p. 389.
[2] Geology of Russia and the Ural Mountains, vol. i, Appendix A, p. 628.
[3] Report on the Geology of Londonderry, &c., p. 324, pl. xxii A, fig. 3 *a*, *b*, *c*.

FENESTELLA (HORNERA?) RAMOSA, *King*. Idem.
— — ,, Tennant, Strat. List Brit. Foss., p. 88, 1847.
CERATOPHYTES DUBIUS, *Schl.* King, Catalogue, p. 6, 1848.
FENESTELLA RAMOSA, *King*. Howse, T. F. N. C., vol. i, p. 261, 1848.
— ANCEPS ET F. DUBIA, *Schl.* Geinitz, Versteiner., p. 18, pl. vii, fig. 23, 1848.

Diagnosis.—*Stems* or *branches* somewhat thick; numerous; frequently dividing; and slightly rounded on both surfaces: each of which marked with distinct flexuous longitudinal lines. *Cellules* from three to six on the width of a stem; arranged in quincunx or somewhat in linear series longitudinally, and oblique in the opposite direction; prominent, especially on the sides of the branches, to which they, in some instances, give a denticulated appearance. *Cellule-apertures* generally assuming a circular form.[1]

This Coral has often been confounded with the next species, but it possesses characters, which it is considered, not only give it a specific, but a generic individuality. This has evidently arisen from the extremely variable character which it frequently displays, almost every specimen offering a modified aspect. The cellules are more apart in some than in others; irregularly arranged in this specimen; disposed in longitudinal series in that; and curving obliquely across the branches in another, as in *Idmonea:* they vary, too, in number; from three to six on the width of a branch: the form of their aperture is also very variable, being either circular or oval. Figures 7, 9, 10, and 11, in Plate V, exhibit, besides these modifications, a difference in the branching: one shows the stems decidedly free (Pl. V, fig. 7); the other, conjoining (Pl. V, fig. 10),—in short, simulating the character of *Synocladia;* another specimen before me shows an approach to the regular truncated, bilateral branching of the next genus. Goldfuss has figured a specimen of *Thamniscus dubius*,[2] with the branches apparently, and in some cases, perhaps, really anastomosing, as in *Synocladia virgulacea*; which has probably led Mr. Morris to identify the latter with the former; but this is a character to be met with only occasionally, and generally near the root of the Coral. In the specimen under figure 11, in Plate V, there is displayed above some of the cellule-apertures (*a*) a small hemispherical body (*b*), which, when removed, leaves a distinct annular impression (*c*). The hemispherical bodies vary occasionally in position, being more or less elevated with reference to the upper lip of the apertures; and in a specimen of the same Coral, which I procured at Könitz, a few appear to be situated a little within the cellules immediately under the lip. There can be no doubt as to these bodies being casts of shallow cup-shaped cavities, similar to those observable in certain *Lunulites*, and in the *Cellaria salicornia:* and from their position, they may safely be

[1] The following is Goldfuss's diagnosis: "Gorgonia ramis dichotomis pinnatis, pinnulis subopposites ramis pinnulisque scabris." (Petrefacta Germaniæ, vol. i, p. 18.)

[2] Petrefacta Germaniæ, pl. vii, fig. 1 *a*, *b*, *c*.

concluded to be the homologues of the gemmuliferous vesicles often seen overlying the cellule-apertures of Bryozoic Corals.

As the mode of formation of the gemmuliferous vesicles is not generally known, a few particulars on the subject, as supplied by an examination of some recent forms, may not be altogether inappropriate. In *Elasmopora* (*Beaniana*) they are prominent and spherical: their basal or attached portion, somewhat cup-shaped, is first formed; next their lateral margins, which arch over to within a short distance of each other, leaving a narrow longitudinal fissure. In *Escharina* the vesicle in its early stage resembles the latter; its lateral margins, however, do not remain separated, but become confluent, forming an irregular dome-shaped appendage: whether the foramina with which its outer or convex wall is furnished, answer the purpose of an opening, or there is one on its proximal or inferior part, that is, in proximity to the upper lip of the cellule-apertures, I am not enabled to say. In *Cellaria salicornia* the gemmuliferous chamber is neither prominent nor spherical, but always remains sunk in the substance of the Coral, forming a cup-shaped cavity, as it evidently is in *Thamniscus dubius:* at first there is a difficulty in distinguishing it from the adjacent inferior cellule-aperture; afterwards, however, it becomes gradually separated from the latter by the interposition of a narrow calcareous dissepiment; and its opening, at first circular, is gradually converted into a transverse linear fissure.

Besides the gemmuliferous chambers in *Thamniscus dubius*, but where they are absent, there is occasionally seen what may be termed an accessory vesicle on both sides of the distal lip of the cellule-apertures, as represented in Plate V, fig. 11 *a*, which reminds one of a similar structure a little below and on both sides of the proximal lip of the cellule-apertures in certain Escharinas.

In some specimens of *Thamniscus dubius*, as in the one represented under figure 12, Plate V, the proximal lip is furnished with a denticle-like process, which occasionally varies a little between the right and left of its usual position.[1] In a few instances I have observed *casts* of the same appendage, showing it to have been hollow, and homologous with the hollow mucronate process similarly situated in *Cellepora Skenei*, in which the mucro is furnished with two foramina on the upper side and near the base. *Elasmopora Beaniana* possesses a similar process, but it is foraminated at the point. I have not been able to discover, as yet, any foramina in the corresponding part of the fossil.

The first synonym quoted for this species is explained by the fact, that Schlotheim imagined its branches to be the arms of a *Cyathocrinus ramosus* incrusted with a *Thamniscus dubius*.

Thamniscus dubius is not a common Coral, though it is pretty generally distributed. It occurs at Tunstall Hill, Ryhope Field-house Farm, Castle Eden Dene, Humbleton

[1] In the impression of the fossil represented in Plate V, fig. 11 *e*, there is a pit or depression of the same appendage under some of the cellule-apertures.

Quarry, and Hylton North-Farm, in the Shelly Magnesian Limestone. In consequence of Geinitz confounding it with the next Coral, it is difficult to make out its German habitats from the 'Versteinerungen,' but it appears to be widely distributed in the Thuringerwald. Schlotheim and Goldfuss mention its occurrence at Glücksbrunn; I collected it myself at Schlossberg von Könitz, where it occurs rather plentifully.

Genus *Acanthocladia*, King, 1849.

Ceratophytes (anceps), *Schlotheim.*
Gorgonia (id.), *Goldfuss.*
Retepora (pluma), *Phillips.*
Glauconome (bipinnata), *Phillips.*
Fenestella (anceps), *Lonsdale.*

Diagnosis.—"A Thamniscidia. *Stems* symmetrically and bilaterally branched more or less on one plane; rarely bifurcating. *Branches* short, simple, occasionally elongated, and becoming bilaterally branched. *Stems and branches* celluliferous on the side overlooking the imaginary axis of the Coral. *Cellules* imbricated, and arranged in longitudinal series. *Series of cellules* separated from each other by a dividing ridge. (?) *Gemmuliferous vesicles* on the dividing ridges."[1]

Type, *Ceratophytes anceps*, Schlotheim.

The Corals which it is proposed to place in this genus have often been included in Goldfuss's *Glauconome*, which is typified by a tertiary-like Cellaria-salicornia fossil (*G. marginata*, Münster, 'Pet. Germ.,' p. 100, pl. xxxvi, fig. 5), undoubtedly belonging to a genus previously established by Defrance, under the name of *Vincularia*. In this case the name *Glauconome* becomes obsolete. This, together with the circumstance that no genus is known to the writer as available for a number of species represented by the *Ceratophytes anceps*, have induced him to institute the one under consideration. Such species as *Retepora pluma*, *Glauconome bipinnata*, *G. pulcherrima*, *G. grandis*, and several others, fall at once into the group, without a doubt being raised of their congenerism.

Acanthocladia is readily distinguished from *Thamniscus* by its symmetrical and bilateral branching, its stems being rarely dichotomous, and the simple form of most of its branches. In *Acanthocladia* branching rarely happens through the stems bifurcating: it is due to the development of some of the bilateral offsets: whereas the reverse obtains in *Thamniscus*,—the branching in this genus being due to the terminal forking of the stems. Another important difference consists in the position and character of the gemmuliferous structures. Assuming certain prominences observable in *Ceratophytes anceps* to constitute these organs (but it is not of much importance whether they do so or not, since their absence in *C. dubius* still constitutes a difference),

[1] Annals and Magazine of Natural History, 2d series, vol. iii, p. 389, 1849.

it may be said that in *Acanthocladia* the gemmuliferous vesicles are prominent, and situated on ridges which separate the rows of cellules; whereas in *Thamniscus* they are cup-shaped cavities overlying the cellule-apertures.

Mr. M'Coy's genus *Ichthyorachis* appears to be closely related to *Acanthocladia* in its mode of branching; but the arrangement of the cellule-apertures favours the idea of its reproductive character being similar to that of *Thamniscus*.

All the known species of *Acanthocladia* are confined to the Palæozoic formations.

ACANTHOCLADIA ANCEPS, *Schlotheim*. Plate V, figs. 13, 14, 15, 16, 17, 18.

KERATOPHYTES ANCEPS, *Schl.* Münch. Akad., vol. vi, p. 20, pl. ii, fig. 7, 1820.
— — „ Petrefacten, p. 341, 1820.
CERATOPHYLLITES — *Schl.* Boué, Edin. Phil. Journ., vol. xii, p. 144, 1825.
GORGONIA — „ Goldfuss, Petref., p. 98, pl. xxxvi, fig. 1 *a*, *b*, *c*, *d*, 1828. (?)
AN UNKNOWN CORAL, *Sedgwick*. Trans. Geol. Soc. Lond., 2d series, vol. iii, pl. xii, fig. 7, 1829.
GORGONIA ANCEPS, *Schl.* Germ. Transl. Geol. Man., p. 459, 1832; and 3d Eng. ed., p. 572, 1833.
— — „ Phillips, Encyc. Met., vol. vi, p. 615, 1834.
— — „ Geinitz, Neues Jahrbuch, p. 541, 1841.
— — ET G. DUBIA, *Schl.* Morris, Catalogue, p. 38, 1843.
— — „ Geinitz, Gæa von Sachsen, p. 98, 1843.
FENESTELLA — „ Bull. Soc. Géol. France, 2me sér., vol. i, p. 24, 1844.
— — „ Geol. Russia, vol. i, p. 221, 1845.
— — „ Tennant, Strat. List Brit. Foss., p. 88, 1847.
CERATOPHYTES — „ King, Catalogue, p. 6, 1848.
FENESTELLA — „ Howse, T. N. F. C., vol. i, p. 261, 1848.
— — ET G. DUBIA, *Schl.* Geinitz, Verstein., p. 18, pl. vii, figs. 19, 20, 22, 1848.

Diagnosis.—Stems numerous, erect, frequently dividing pinnately. *Pinnules* slightly tapering, generally opposite to each other, and blunted at their extremity. *Rows of cellules* from three to six on the stems. *Cellule-apertures* more or less circular, and somewhat apart. *Capillary tubes* slightly flexuous.[1]

This Coral consists of a number of long, slender stems, rising from a small base round an imaginary axis, and giving off bilaterally, and at regular distances from each other, numerous branches, generally short and simple, but occasionally elongated, also bilaterally branched, and sometimes still further developed in the same way, assuming, in short, a bi- and even a tri-pinnated form. The rows of cellules, separated from each other by a slightly-developed dividing ridge, are variable in number: generally there are only three; but in some specimens so many as six may be counted. The vertical

[1] The following is Goldfuss's diagnosis: "Gorgonia ramosissima, ramis subdichotomis, ramulis distichis brevibus, cortice osculis papillosis serialibus costata." (Petrefacta Germaniæ, vol. i, p. 98.)

capillary tubes are slightly flexuous, which gives a waved striated appearance to the non-celluliferous surface of the Coral.

Figure 17, in Plate V, represents a magnified view of the impressions made by a portion of a stem; showing the pits or depressions (*b*) resulting from the supposed gemmuliferous vesicles, on lines produced by the slightly-developed dividing ridges: also, the whole of the surface intervening the cellule-apertures (*a*), perforated by pores or minute foramina.

Both Goldfuss's figure (pl. xxxvi, fig. 1 *d*) and description of this species represent the rows of cellule-apertures situated on broad, rounded ridges, instead of furrows, as they have invariably occurred to me. I notice this discrepancy without being able to explain it, but in hopes of drawing the attention of some one to the original specimen figured in the 'Petrefacta,' and now probably in the University Museum of Bonn.

Acanthocladia anceps occurs at Tunstall Hill, Dalton-le-Dale, Ryhope Field-House Farm, Castle Eden Dene, Humbleton Quarry, Hylton North-Farm, and Whitley, in Shelly Magnesian Limestone; and at Black Hall Rocks and Tynemouth Abbey Cliff, in Breccia. It is widely distributed over the Permian region of Germany; occurring in the Lower Zechstein of Corbusen, Milbitz, Schwaara, Dinz, and Hergisdorf; in Zechstein at Kamsdorf; and in Zechstein-Dolomite at Pösneck, Oppung, Könitz, Liebenstein, and Glücksbrunn (Geinitz).

Class Echinodermata, Cuvier.

This class has lately been divided into seven orders, viz. *Cystideæ, Crinoideæ, Echinideæ, Stellerideæ, Ophiurideæ, Holothurideæ,* and *Sipunculideæ,* of which the second and third are the only Permian kinds at present known.

Order Crinoideæ,[1] Miller, 1821.

Diagnosis.—"Radiated animals, having the body regular; provided with five pinnate articulated rays, a central mouth, a visceral cavity, and a distinct anus; and supported on an articulated stem fixed by its base."[2] (Milne Edwards.)

Crinoideas, like most of the groups herein described, though they flourished abundantly during the early periods of the world's organic history, only constitute an insignificant feature in existing creation. The *Pentacrinus Caput-Medusæ,* an inhabitant of the West Indian seas; the beautiful *Comatula rosacea,* belonging to our own coasts;

[1] "I have derived the name of this family from the Greek ΤΑ ΖΩΑ ΚΡΙΝΟΕΙΔΕΑ, the lily-shaped animals, and have used the word to form, with another distinguishing term prefixed, the name of the genera." (Miller, 'A Natural History of the Crinoidea, &c.,' 1821.)

[2] Lamarck's Animaux sans Vertèbres, 2d ed., vol. ii, p. 652.

and the singular *Holopus Rangii* of Martinico, are the principal known forms remaining of an order the débris of which in many cases form entire mountain masses.

Having existed so abundantly during former periods, it may be readily conceived that the order *Crinoideæ* comprises a large number of genera; but it is only the following one which it is the province of this Monograph to notice.

Genus *Cyathocrinus*,[1] Miller, 1821.

Diagnosis.—"A crinoidal animal, with a round or pentagonal column formed of numerous joints, having side arms proceeding irregularly from it. On the summit adheres a saucer-shaped pelvis of five pieces, on which are placed in a successive series, five costal plates, five scapulæ, and an intervening plate. From each scapula proceeds one arm having two hands."[2] (Miller.)

Cyathocrinus, concluding from what is still known of its chrono-geological range, is decidedly a Palæozoic genus; not being known to occur in any formations superior to the Permian. It is also found in the immediately underlying Carboniferous rocks. *Cyathocrinus planus* is the typical species.

Cyathocrinus ramosus, *Schlotheim*. Plate VI, figs. 15-20.

Pentacrinites fasciculosus, *Knorr*. Schlotheim, Taschenbuch, p. 57, 1813.
Encrini, *Thomson*. Annals of Philosophy, vol. iv, p. 417, 1814.
Cup Encrinite, *Parkinson*. Winch, Trans. Geol. Soc. Lond., vol. iv, p. 10, 1817.
Encrinites ramosus, *Schl*. Akad. Münch., pp. 20-24, pl. ii, fig. 8, pl. iii, figs. 9-15 *a*, *b*, 1820.
— — „ Petrefactenk., p. 330, 1820.
Cyathocrinites planus, *Miller*. Nat. Hist. Crinoidea, p. 85, 1821.
Pentacrinites ramosus, *Schl*. Boué. Edin. Phil. Journ., vol. xii, p. 144, 1825.
Cyathocrinites planus, *Miller*. Sedgwick, Trans. Geol. Soc. Lond., 2d series, vol, iii, p. 120, 1829.
Encrinites ramosus, *Schl*. Al. Brongniart, Tab. de Terr., p. 423, 1829.
Cyathocrinites planus, *Miller*. De la Beche, Geol. Manual, p. 385, 1831; Germ. Transl. ditto, p. 459, 1832; 3d Eng. ed. p. 572, 1833.
Encrinites ramosus, *Schl*. Op. cit.
— — „ Phillips, Encyc. Metr., vol. vi, p. 615, 1834.
Cyathocrinus planus, *Miller*. Loc. cit.
— — „ Morris, Catalogue, p. 51, 1843.
— — „ Geinitz, Gæa von Sachsen, p. 90, 1843.
Encrinites ramosus, *Schl*. De Verneuil, Bull. Soc. Géol. Fr., 2^{me} série, vol. i, p. 25, 1844.

[1] "The name of this genus is derived from ΚΥΑΘΟΣ, a cup." (Miller, op. cit., p. 85.)
[2] Loc. cit.

Encrinites ramosus, *Schl.* Geol. Russ. vol. i, p. 221, 1845.
Cyathocrinites planus, *Miller.* Geinitz, Grundriss, p. 548, 1846.
Encrinites ramosus, *Schl.* Tennant, Strat. List., p. 88, 1847.
Cyathocrinus — ,, King, Catalogue, p. 6, 1848.
Encrinites planus, *Miller.* Howse, T. N. F. C. vol. i, p. 261, 1848.
Cyathocrinus ramosus, *Schl.* Geinitz, Versteinerungen, p. 16, pl. vii, figs. 3-6, 1848.

Diagnosis.—*Cup* twice as wide as it is high at the margin; sides at an angle of about fifty degrees. *Basal or pelvic plates* diamond-shaped; inner portion the longest. *Supra-basal or costal plates,* four normals pentagonal; inferior margin slightly convex; sides of nearly equal length: modified plate six-sided: surface of all a little rounded. *Marginal or scapular plates,* brachials pentagonal; with the latero-superior angles truncated; twice as wide as it is deep; upper margin slightly concave: articulating areas marginal; nearly as wide as the upper margin of the plate: abrachial plate irregularly six-sided: supplementary abrachial four- or five-sided. *Column* branched, rounded, with (?) both plane and beaded internodes, and a pentagonal canal: articulating surfaces slightly concave; with an inner granulated area, and an outer radiately-marked zone.

The marginal plates (Pl. VI, fig. 18 *e*) of the cup of this Cyathocrine are unusually broad compared with their depth, and the size of the supra-basal plates (*c*). The consequence is, that the cup is much wider at the top than at the base. The basal plates, in the only cup I have seen, and which is the one figured, have their surface broken off; it is therefore impossible to say whether they were rounded, thereby giving the lower part of the cup a corresponding form, or level, with a surface at the same angle as the plane of the upper plates, making the entire sides of the cup entirely flat, and passing continuously so into the column. It is suspected, however, that the latter character obtained. There are two kinds of internodes occurring in our rocks: the commonest is plane (Pl. VI, fig. 20); and the rarest is beaded (Pl. VI, fig. 19): both probably belong to the same species, since other Crinoideas, e. g. *Encrinus liliformis,* are known to possess a column composed of both plane and beaded internodes. Dr. Geinitz figures only plane internodes; but Schlotheim has represented beaded examples in pl. iii, figs. 11, 12, of his 'Beiträge.' I have not yet succeeded in procuring any specimens of the arms or the branches of *Cyathocrinus ramosus;* though single joints have now and then occurred to me. Schlotheim erroneously figured specimens of *Thamniscus dubius* and *Acanthocladia anceps,* as arms, or branches; but the only representation given by the Baron, and referable either to the one or the other of these appendages, is under fig. 10, in his 11th plate, which exhibits them incrusted with a *Stenopora columnaris.*

The author of the 'Natural History of the Crinoidea,' simply from an examination of the columns of this species, was led to identify it with his *Cyathocrinus planus;* the cup, however, shows it to be very distinct from the latter, particularly in the width of its marginal or scapular plates.

Cyathocrinus ramosus occurs rarely in the Shell-limestone at Tunstall Hill and Silksworth; abundantly in the corresponding rock at Humbleton Hill; and rather uncommonly in the Breccia at Tynemouth. Geinitz records its occurrence in the Lower Zechstein of Corbusen; and in the Zechstein-Dolomite of Asbach, Schmalkalden, Pösneck, and Kamsdorf. According to Schlotheim, it is found at Glücksbrunn and Liebenstein.

Order Echinideæ, Cuvier.

This order, of which the common Sea-urchin (*Echinus esculentus*) of the English coasts is a good representative, consists of a large number of genera, both living and extinct; but the following one is the only form known to be Permian.

Genus *Archæocidaris*, M'Coy.

Diagnosis.—"Interambulacra composed of three or more rows of plates, those on each side, next the ambulacra, pentagonal; those of the immediate rows hexagonal, as in *Palæchinus;* each plate having in the centre one large perforated tubercle, surrounded by an elevated ring, as in Cidaris, each of which tubercles bears a large, mobile, generally muricated spine."[1] (M'Coy.)

"It is a singular circumstance that, except Professor Agassiz, every author who has treated of the *Echinodermata* of the Mountain-limestone, should have referred the hexagonal plates with the above characters to the genus *Cidaris,* when a glance at the recent or Oolitic Cidarites would be sufficient to show that in their entire framework there is not one hexagonal plate, both the ambulacra and interambulacra being composed each of *two* rows of pentagonal plates only, while in the present genus, as in *Palæchinus*, their interambulacra must have been composed of more than two rows, as is obvious from their hexagonal form; the large, perforated tubercle, however, is precisely in accordance with that of the true *Cidaris,* as is also the mode of attachment and general character of the large spines with which both genera are armed. . . . . I had long ago distinguished this genus in my MSS. under the name of *Archæocidaris,* subsequently Professor Agassiz announced his intention of forming the genus *Echinocrinus* for the *Cidaris Nerii*, &c."[2]

Though Agassiz's name is adopted by Professor M'Coy, yet later writers, from the circumstances above related, have been led to give the preference to the name *Archæocidaris.* M. Agassiz, with his colleague M. Desor, has lately changed the name into *Palæocidaris.*

[1] Carboniferous Limestone Fossils of Ireland, p. 173.

[2] Idem.

ARCHÆOCIDARIS VERNEUILIANA, *King*. Plate VI, figs. 22-24.

CIDARIS, *King*. De Verneuil, Bull. Soc. Géol. Fr., 2me série, vol. i, p. 25, 1844.
— „ Geol. Russ., vol. i, p. 221, 1845.
— VERNEUILIANA, *King*. Catalogue, pp. 6, 7, 1848.
— Howse, T. N. F. C., vol. i, p. 261, 1848.
— KEYSERLINGI, *Geinitz*. Versteinerungen, p. 16, pl. vii, figs. 1, 2, 1848.

Diagnosis.—"*Interambulacral plates* sub-hexagonal, a little longer transversely than longitudinally. *Socket-balls* large, perforated, placed on elevated bases. *Glenoid circles* radiately crenulated. *Muscular areas* concave, somewhat broad, surrounded with an elliptical border of small tubercles in a single series."[1]

The diagnosis of *Archæocidaris Verneuiliana* must still remain imperfect until specimens more complete than any I have seen are found.

Not having discovered any specimens with ambulacra, or more than two contiguous rows of interambulacral plates, it is unsafe positively to consider this species as belonging to the genus in which it has been placed. The sub-hexagonal form of the plates which have fallen under my notice, has principally led me to regard it as an *Archæocidaris;* a view which seems to be strongly supported by the corresponding form of the interambulacrals, in two contiguous rows, figured by Geinitz.

One of the specimens represented (Pl. VI, fig. 23) exhibits the longitudinal spaces between the muscular areas with three or four rows of small tubercles, in addition to the "single series" noticed in the diagnosis; and in the illustrative specimen given by Geinitz, there are two intervening rows. Two kinds of spines occur in the rock containing this fossil; one is muricated, as in the specimen represented under fig. 24, and the other is finely longitudinally striated.[2] The spine figured by Dr. Geinitz appears to be rather different from the one herein represented, but it is probable the difference is in the figure, and not in the fossil.

Archæocidaris Verneuiliana is a rare species. The only localities where it is found are Tunstall Hill, and Humbleton Quarry, in Shell-limestone. Corbusen, in the under Zechstein, is the single German station recorded for it by Geinitz.

[1] Catalogue of the Organic Remains of the Permian Rocks of Northumberland and Durham, pp. 6, 7, 1848.

[2] Through an oversight, an error was committed in my 'Catalogue' as regards the occurrence of the "transversely-ridged" spine therein mentioned.

Sub-kingdom ARTICULATA, Cuvier.

The Permian epoch, so far as its Fauna is yet known, appears to have only witnessed two (the first and second) of the five classes, viz, *Annellata, Crustacea, Arachnida, Insecta,* and *Cirrhopoda,* into which the extensive group of Articulated animals has been divided.

Class Annellata, (*Les Annélides*) Cuvier.

Audouin and Milne Edwards, the ablest writers on this class, have divided it into four orders, which they name *Annellata suctoria, A. terricola, A. tubicola,* and *A. errantia,* respectively represented by the Leech, Worm, Serpula, and Sea-mouse. Only the third order requires our immediate attention.

Order Tubicolæ, Cuvier.

The only known Permian genera of this group are the following, all of which, with the exception of the so-called *Serpula* (?) *pusilla,* are still in existence.

Genus *Spirorbis,* Lamarck,[1] 1801.

Diagnosis.—"Vermis tubo calcareo inclusus, branchiis pectinatis antice coronatus, stylo carnoso exserto in discum dilato. Tubus spiraliter contortus."[2]

This genus, first separated from the Linnæan group, *Serpula,* by Lamarck, is distinguished by some peculiarity in its branchial filaments, and in having a regularly spiral-formed orbicular shell attached by a flattened disc to foreign bodies. It is typified by the *Serpula Spirorbis,* Linn., common on our coasts.

Spirorbis helix, *King.* Plate VI, figs. 8, 8 *a.*

Spirorbis helix, *King.* Catalogue, p. 6, 1848.
— globosus, *M'Coy.* Howse, T. N. F. C., vol. i, p. 258, 1848.

Diagnosis.—*Form* conical. *Whorls* smooth, somewhat broad, numerous, overlying each other, and sub-umbilicated. *Aperture* of a crescentic shape, having its concave or inner lip pressed in by the underlying whorl.

Figure 8, in Plate VI, is a magnified view of a young specimen. As the shell increases in size, the whorls leave the base, and rise to the summit, overlying the old

[1] Systême des Anim. sans Vertèbres, &c., p. 326, 1801.
[2] Apud Schweigger, Handbuch, &c., p. 601.

ones, in which state the basal outline does not exhibit any break where the aperture is situated; on the contrary, it is nearly a true circle. *Spirorbis globosus*, with which this fossil has elsewhere been identified, is decidedly umbilicated, has a broad, rounded back, and a circular aperture—characters which widely separate both species from each other.

Spirorbis helix occurs at Humbleton, attached to *Productus horridus*, *Fenestella retiformis*, and other foreign bodies. I found a specimen adhering to a Spirifer in the Breccia at Tynemouth.

SPIRORBIS PERMIANUS, *King*. Plate VI, figs. 9, 9 *a*.

SPIRORBIS HELIX, in parte, *King*. Catalogue, p. 6, 1848.
(?) — OMPHALOIDES, *Goldfuss*. Howse, T. N. F. C., vol. i, p. 259, 1848.

Diagnosis.—Smooth (?); depressly convex; with a wide umbilicus.

The imperfect state of the specimens which I have examined of this species, and the difference, in geological age, between it and the *Serpula omphaloides* of Goldfuss, prevent my agreeing to the identification made in the above synonymy in the work last cited; and I am prevented, by another consideration, identifying either this or the preceding species with the *Serpula planorbites*, Münster, first published by Geinitz in his 'Gæa von Sachsen,' and afterwards represented in the 'Versteinerungen' (pl. iii, figs. 1, 2). Unfortunately, the figures just quoted only represent the attached side of the fossil; it is therefore evident, that without having some knowledge of its free side, any identification would be both premature and unwarranted. Do not the figures of *Serpula planorbites*, in the 'Versteinerungen,' represent the aperture on the wrong side?

Spirorbis Permianus differs from *S. helix* in having a decided umbilicus, slender whorls, and in being depressed on its free side.

I have only found specimens near Byers' Quarry, north of Marsden rocks, in (? Rauchwacke) Limestone.

Genus *Filograna*, Berkeley.

Diagnosis.—"*Shell* very slender, filiform, gregarious. *Branchiæ* 8, filiform, of which two bear an infundibuliform, obliquely-truncated operculum. *Mantle* rectangular. *Fascicles of bristles* 7 on each side."[1] (Berkeley.)

Although here introduced, the Permian existence of this genus is a subject of considerable doubt. Can the *Serpula parallela* of M'Coy[2] be a Palæozoic form of it?

[1] Zoological Journal, vol. v, p. 427.

[2] Carboniferous Limestone Fossils of Ireland, p. 169, pl. xxiii, fig. 30.

A fancied similarity between this fossil and the next to be noticed has principally led me into the present subject-matter. The Rev. Mr. Berkeley founded the genus on the *Serpula filograna* of Linnæus.

FILOGRANA (?) PERMIANA, *King*.

SERPULA OR DENTALIUM (?), *Sedgwick*. Trans. Geol. Soc. Lond., 2d series, vol. iii, p. 118, 1829.

Diagnosis.—Tubes cylindrical, acicular, slightly tapering.

The fossils referred to the above-noticed "*Serpula* or *Dentalium*" are exceedingly obscure. The weathered surface of some of the beds at the south end of Black Hall Rocks often exhibit them confusedly crowded together, in the state of flattened casts, and seldom more than an inch in length; they appear to be merely fragments. When the Rock is broken, cross sections of the fossil are obtained, showing it to be quite cylindrical in form.

The exact locality which yielded this fossil to Professor Sedgwick, and where I have also collected it, is the south end of Black Hall Rocks, on the Durham coast, about five miles north of Hartlepool. A similar production is stated to occur "in the upper beds at Cold Hill, near Aberford."[1] (Sedgwick.) A doubtful fossil, hesitatingly referred to the same species, occurs in a quarry of (? Rauchwacke) Limestone, near Cleadon.

Genus *Vermilia*, Lamarck.

Diagnosis.—"Tubus testaceus, cylindraceus, postice sensim attenuatus, plus minusve contortus, repens, corporibus marinis latere affixus. Apertura rotunda; margine dente unico vel dentibus duobus tribusve sæpe armata."[2]

While *Serpula*, a closely-related genus, is attached only by a portion of its tube, *Vermilia* is adherent by its entire length.

Type, *V. rostrata*.

VERMILIA OBSCURA, *King*. Plate VI, fig. 15.

SERPULA OBSCURA, *King*. Catalogue, p. 6, 1848.
— MINUTISSIMA, *Howse*. T. N. F. C., vol. i, p. 258, 1848.

Diagnosis.—Semicylindrical, tortuous, very small. *Mouth* inclined.

This small species is occasionally found attached to *Fenestella retiformis*, *Cyathocrinus ramosus* (as in the cup under figure 15, in Plate VI), *Productus horridus*, *Camerophoria*

[1] Trans. Geol. Soc. Lond., 2d series, vol. iii, p. 118.
[2] Anim. s. Vertèb., édit. nouv., tom. v, p. 632.

Schlotheimii, and other fossils occurring at Tunstall Hill and Humbleton. A few imperfect casts have occurred to me in the (? Rauchwacke) Limestone beds exposed at low tide, opposite Hendon, near Sunderland: they may belong to a different species.

SERPULA (?) PUSILLA, *Geinitz*. Tab. VI, figs. 7-9; Tab. XVIII, fig. 13 *a*, *b*, *c*, *d*.[1]

FORAMINITES SERPULOIDES, (provisional), *King*. 1848. Catalogue, p. 6.
SERPULA PUSILLA, *Geinitz*, 1848. Versteiner. Zechsteingebirg. und Rothliegend., p. 6, tab. iii, figs. 3-6.

	INCH.
Length,	$\frac{1}{20}$
Breadth,	$\frac{1}{30}$
Thickness,	$\frac{1}{30}$

An oblong coil of sub-cylindrical, wire-like folds, white and granular. A central, irregularly-twisted mass, of about $\frac{1}{50}$ inch in diameter (see fig. 13 *c*), is inclosed in eight or nine outer folds; these are flat or slightly concave on their internal surface, and convex externally, and are arranged longitudinally, not all on the same plane, but, with the exception of the outermost folds, crossing each other at the extremities of the coil at nearly right angles.[2] The size of the folds gradually increases from within outwards, but is subject to irregularities.

This minute fossil appears to be the cast of a tubular shell, there being more or less space between each of the larger folds, which are in consequence rendered extremely brittle. The shell, probably, was free and unattached. It sometimes occupies an oblong, smooth cavity, which is not, however, excavated in any shell or foreign substance, but appears to have been formed by the removal of the shell of the Annelid after it was surrounded by the calcareous deposit.

This little fossil appears to be identical with the species figured and described by Geinitz (loc. cit.) as *Serpula pusilla*, from the Lower Zechstein of Corbusen, near Ronneburg.

It is of frequent occurrence in the Limestone at Humbleton.

[1] By Mr. T. RUPERT JONES.

[2] The outer folds of this fossil bear some resemblance to those of the shells of some of the Agathistegia, M. d'Orbigny's sixth Family of Foraminifera. The structure and arrangement, however, both of the inner and the outer coils, present such important differences from the essential characters of the Foraminifera referred to, that we can only be allowed this passing remark on the subject.

Class Crustacea.[1]

The microscopic Infusoria, as well as the grain-like Foraminifera and their allies, the comparatively massive Nummulites, have not only by their enormous local accumulations demanded the admiration of the student of geology, but by the wonders of their form and structure have called for the assiduous labour of some of the first naturalists of the day. The endless variety of these Microzoa, together with the little Coral-polyps and their congeners, have exercised the skill and excited the eloquence of collector and author ; there remains, however, a group of minute animals that have well performed their part in building up the rocks of this globe of ours, but which have met with little attention and less notoriety. We allude to the Entomostracous Crustacea,—a group of considerable value in a palæontological point of view, and well entitled to rank amongst those minute organisms, whose rapid multiplication and frequent exuviations have, by local aggregation, given rise to, and are still producing, those astonishing lithological results, which, though passed over unnoticed by the many to whose comfort or even existence they are subservient, or to whose injury or inconvenience they tend, are viewed with careful earnest eye by the natural philosopher, tracing the most important results from apparently the meanest source.

In 1793, the Rev. Dr. Ure, of Rutherglen, noticed the existence of certain "microscopic bivalve shells" (Cytheres) in the Limestone near Glasgow, and collecting a sufficient quantity, supplied his friends with suites of the little fossils, and a tastily-mounted set in a glazed frame is still preserved in the Hunterian Museum. But it was not until twenty years afterwards that any fossil species of Entomostraca was recognised and described.

M. Desmarest in 1813 figured and described his *Cypris Faba* from a tertiary fresh-water formation. Six years afterwards, this was followed by a notice of one or more of the Cyprides of the Wealden by Prof. Sedgwick. Another interval of five years, and M. Alex. Brongniart notices a tertiary species from France and Germany ; and other Wealden species are figured and described by Dr. Fitton and Mr. Sowerby. In 1826, M. Hisinger describes two species of Entomostraca from the Silurian rocks ; and four years afterwards, Count Münster describes fourteen tertiary species, and eight species from the Mountain-limestone.

After this slow progress our knowledge of the fossil Entomostraca, or rather Ostracoda, advanced more rapidly. Mr. Lonsdale discovered Cythere in the English Chalk. M. Rœmer added several species to Münster's list, figuring all the tertiary species of Germany, and in 1842 he figured and described seven species from the Chalk. Reuss, Koninck, Cornuel, Bosquet, Phillippi, Dunker, Hibbert, Horner, Phillips, Murchison, M'Coy, Portlock, Sowerby, Bean, Morris, Williamson, &c., added other species from various sources ; but as yet only two or three groups of sedimentary

[1] By Mr. T. Rupert Jones.

deposits have been searched for these interesting organic remains, and even these rocks are doubtlessly not yet exhausted of the many varieties of Ostracoda and their allies, which lived and died in the shallows and depths of the ancient waters. The Upper Silurian Limestones, with their accompanying layers of calcareous grit, the Lias, locally rich in these and other Microzoa, and the Oolites, frequently swarming with Ostracoda, are yet unsearched.

The various strata of the Tertiary, Cretaceous, Wealden, and Carboniferous formations, have been partially worked over, and the result of an examination of two deposits of the Permian system is now before us. To this we will now turn, confident that further researches in the calcareous and argillaceous deposits of nearly all geological epochs will discover stores of Entomostraca, if not so overflowing as in some of the strata of the Gault, the Wealden, the Upper Oolite, and the Magnesian Limestone, yet enough to reward earnest search with many additional and instructive forms.

We must, however, premise that there have been several species of Ostracodous Crustacea described as occurring in the older secondary rocks. M. Hisinger has figured and described two species from the Silurian rocks of Sweden;[1] Count Münster has given short descriptions of eight species from the Bergkalk of Regnitzlosan, near Hof;[2] Prof. M'Coy has figured and described twenty-two species from the Carboniferous Limestone of Ireland;[3] Dr. de Koninck six species from the Carboniferous System of Belgium;[4] and Mr. Bean one species from the Newcastle Coal-beds.[5] Two fresh-water species are figured and described in Portlock's 'Geol. Rep. of Londonderry;'[6] one in Murchison's 'Sil. Syst.;'[7] and others by Dr. Hibbert[8] and Mr. Horner.[9] Some of these species having been noticed by two or more authors, there remain about thirty-seven distinct forms belonging to the Silurian and Carboniferous rocks. One species of Cythere, *C. Balthica*, Hisinger, which occurs in the Transition-limestone of Sweden, appears to have been found in the Permian formation of Russia.[10]

Of the ten species obtained from the Magnesian Limestone of North Britain, six are new; and of the others, three occur in the Carboniferous Limestone of Ireland, and one in the Bergkalk of Regnitzlosan.

[1] Trans. Acad. Sc. Stockholm, vol. ii, 1826. Lethæa Suec., 1837, p. 9, tab. i, figs. 1 and 2; and tab. xxx, fig. 1.

[2] Jahrb. f. Min., &c., 1830, p. 65.

[3] Journal Geol. Soc. Dublin, vol. ii, tab. v. Syn. Char. Carb. Limestone Foss. Ireland, 1844, pp. 164-68, pl. xxiii.

[4] Descript. Anim. foss. terr. Carb. Belg., 1842, pp. 584 et seq., pl. lii.

[5] Mag. Nat. Hist., vol. ix, p. 377.

[6] Page 316, pl. xxiv, fig. 13 *b*, *c*.

[7] Vol. i, p. 84, fig. A.

[8] Trans. Roy. Soc. Edin., vol. xiii, p. 179.

[9] Edin. New Philos. Journal, April 1836.

[10] Also in the Devonian and Silurian rocks of Russia. See Murchison, Geol. Russ. vol. ii, p. 394.

General Division ENTOMOSTRACA, Müller, 1785.

This extensive section of the Crustacea comprises several orders of aquatic animals, chiefly of small size, and differing very greatly in their general appearance. The orders are arranged according to the structure of the maxillary and the prehensile apparatus, the characters of the pseudobranchiæ, and the form of the tegumentary shell or cuirass. We may notice, as representatives, the genera Branchipus, Apus, Limnadia, Daphnia, Cyclops, Cypris, Cythere, Argulus, and Lernæa. The Limulus has been placed by Latreille in this section; and according to Mr. Salter, the Trilobite belongs to a co-ordinate group.[1]

Up to the present time no researches of the palæontologist have proved the existence, during the Permian epoch, of other forms of Crustacea than those belonging to this division; two genera only, *Cythere*, Müller, and *Dithyrocaris*, Scouler, have been found in the Magnesian Limestone.

Legion BRANCHIOPODA, Latreille.

Order OSTRACODA, Latreille.[2]

Genus *Cythere*, Müller.

Synonyms. MONOCULUS, *Auct. prior.*
CYTHERE, *Müller*, 1785.
CYTHERINA, *Lamk.*, 1818.

A marine Entomostracous Crustacean. Body of animal inclosed in a bivalve carapace; animal, creeping; provided with three pairs of feet, all protruding from the shell.

In the 'Monograph of the Entomostraca of the Cretaceous Formation,' where we have entered more fully into the characters of the Ostracoda, we have subdivided the genus *Cythere*, Müller, into four groups, viz. *Cythere proper*, *Cythereis*, nob., *Bairdia*, M'Coy, and *Cytherella*, nob., characterised by the form of the carapace and the structure of its hinge. The absence of perfect valves sufficiently free from the matrix to be easily examined, renders it impossible to be quite decided in the arrangement of the ten Permian species of *Cythere* into their respective sub-genera. But taking the general form as a guide, we have considered Nos. 1, 3, 4, and 5 as belonging to *Cythere proper*, Nos. 2, 6, and 9 to *Bairdia*, No. 7 as a *Cythereis*, and Nos. 8 and 10 as *Cytherellæ*.

These Entomostraca occur in considerable numbers in the Limestone from Byers' Quarry, referred to at page 16, both in relief on the weather-worn surface of the

[1] Geolog. Survey, 2d Decade.

[2] See Jones, Monog. Entom. Cret. Form., p. 7.

calcareous Grit, and imbedded in the crystalline Limestone. They also occur, but much more sparingly, in the Limestone of Humbleton, and other localities. Species Nos. 1 and 3 occur exclusively in the latter rock; No. 2 occurs in both rocks; and the others, except No. 4, have as yet been found in the Limestone from Byers' Quarry only.

No. 1. CYTHERE MORRISIANA, *nobis*. Tab. XVIII, fig. 2 *a*, *b*, *c*.

	INCH.
Length,	$\frac{1}{20}$
Height,	$\frac{1}{40}$
Thickness,	$\frac{1}{62}$

Carapace irregular oblong, convex, smooth. *Dorsal and ventral borders* nearly straight, slightly incurved. *Extremities* subacute, suddenly depressed; the *anterior* slightly narrower than the *posterior*.

Dorsal aspect elongate oval, compressed at the ends; *anterior* sub-ovate.

Unique. Locality, Humbleton.

This well-marked species is named after Mr. J. Morris, to whose scientific researches palæontologists are so greatly indebted.

No. 2. CYTHERE (BAIRDIA) CURTA, *M'Coy*. Tab. XVII, figs. 21, 22; and Tab. XVIII, fig. 3 *a*, *b*, *c*.

BAIRDIA CURTUS, *M'Coy*, 1844. Syn. Char., &c., p. 165, pl. xxiii, fig. 6.

	INCH.	INCH.
Length,	$\frac{1}{18}$	$\frac{1}{25}$
Height,	$\frac{1}{30}$	$\frac{1}{50}$
Thickness,	$\frac{1}{45}$	$\frac{1}{100}$

Carapace sub-triangular, convex, smooth. *Dorsal border* projecting; *ventral* sinuous. *Anterior extremity* rounded on its ventral half, and forming an angle with the sloping dorsal border; *posterior* acute.

Dorsal aspect narrow acute oval; *anterior* compressed ovate.

Several specimens exhibit, more or less distinctly, the interior of the valves, which closely resemble those of *B. subdeltoidea*, Münster,[1] of the Chalk and Tertiary formations. The cast (figs. 21, 22), in particular, is similar to the cretaceous species, and not very dissimilar to *B. affinis*, Morris,[2] but the generality of the Permian specimens are narrower, more compressed, and less triangular than the species referred to.

Found by Mr. Griffith in the Carboniferous rocks of Ireland.

Not uncommon at Byers' Quarry and Humbleton.

[1] See Jones, Mon. Entom. Cret. Form., p. 23, tab. v. fig. 15.

[2] Phys. Descript. New S. Wales, &c., p. 291, pl. xviii, fig. 10.

No. 3. CYTHERE GEINITZIANA, *nobis.* Tab. VI, fig. 46; and Tab. XVIII, fig. 4 *a, b, c.*

	INCH.
Length,	$\frac{1}{20}$
Height,	$\frac{1}{30}$
Thickness,	$\frac{1}{30}$

Carapace elongate reniform, convex, smooth, slightly punctated towards the anterior extremity. Rounded anteriorly, slightly bordered, and somewhat depressed; tapering and more convex posteriorly. *Ventral border* sinuous; *dorsal* elliptical, shelving downwards posteriorly to form a subacute angle with the ventral border.

Dorsal aspect elongated ovate; *anterior* ovate.

One specimen from Humbleton.

No. 4. CYTHERE ELONGATA, *Münster.* Tab. XVIII, fig. 5.

CYTHERE ELONGATA, *Münster.* 1830. Jahrbuch f. Min., p. 65, n. 19.

	INCH.
Length,	$\frac{1}{30}$
Height,	$\frac{1}{70}$

Carapace bean-shaped, smooth, convex. *Dorsal and ventral borders* incurved at the middle. *Extremities* rounded; *the anterior* rather oblique.

Münster's description of *C. elongata* (from the Bergkalk of Regnitzlosan) is very succinct, but, as far as it goes, is applicable to this species.

A single specimen, imbedded in a fragment of Magnesian Limestone, dredged up near the Dogger Bank.

No. 5. CYTHERE KUTORGIANA, *nobis.* Tab. XVIII, fig. 6.

	INCH.
Length,	$\frac{1}{30}$
Height,	$\frac{1}{60}$

Carapace somewhat bean-shaped, convex. *Dorsal border* elliptical; its contact-margin thickened, and bearing trace of hinge; *ventral* sinuous. *Anterior extremity* obliquely rounded; *posterior* acute.

This probably belongs to the group of *Cythere proper:* it is not uncommon at Byers' Quarry.

No. 6. CYTHERE (BAIRDIA) GRACILIS, *M'Coy*. Tab. XVIII, fig. 7.

BAIRDIA GRACILIS, *M'Coy*. 1844. Syn. Char., &c., p. 165, pl. xxiii, fig. 7.

	INCH.
Length,	$\frac{1}{35}$
Height,	$\frac{1}{110}$

A cast, much worn, of a carapace nearly allied to *B. curta*, but much narrower; probably Prof. M'Coy's *B. gracilis*.

Locality, Byers' Quarry.

No. 7. CYTHERE (CYTHEREIS ?) BIPLICATA, *nobis*. Tab. XVIII, fig. 8.

	INCH.
Length,	$\frac{1}{48}$
Height,	$\frac{1}{90}$

Carapace sub-ovate, convex, bearing two short, longitudinal, rounded ridges near the middle of the valve. *Dorsal and ventral borders* elliptical. *Anterior extremity* rounded; *posterior* acute.

The hinge of this unique and interesting specimen having disappeared, we can only provisionally place it in the sub-genus Cythereis, to which it is probably allied, particularly to *C. triplicata*, Rœmer,[1] and other similar forms.

Locality, Byers' Quarry.

No. 8. CYTHERE (CYTHERELLA ?) INORNATA, *M'Coy*. Tab. XVIII, fig. 9.

C. INORNATA, *M'Coy*. 1844. Syn. Char., &c., p. 167, pl. xxiii, fig. 18.

	INCH.
Length,	$\frac{1}{50}$
Height,	$\frac{1}{90}$

Carapace nearly oblong, sub-reniform, smooth, convex. *Dorsal border* slightly elliptical; *ventral* almost straight. *Anterior extremity* obliquely rounded; *posterior* semicircular.

This form seems to be identical with *C. inornata*, M'Coy, of the Irish Carboniferous formation.

One specimen from Byers' Quarry.

No. 9. CYTHERE (BAIRDIA ?) ACUTA, *nobis*. Tab. XVIII, fig. 10.

	INCH.
Length,	$\frac{1}{38}$
Height,	$\frac{1}{125}$

Carapace sub-triangular, smooth, convex. *Dorsal edge* rounded, produced; *ventral* nearly straight. *Extremities* acute.

[1] See Jones, Monog. Entom. Cret. Formation, p. 18, tab. iii, fig. 9.

C. acuta differs from *C. gibberula* M'Coy,[1] in being less convex, and having sharper extremities.

A single specimen from Byers' Quarry.

No. 10. CYTHERE (CYTHERELLA?) NUCIFORMIS, *nobis*. Tab. XVIII, fig. 11 *a*, *b*, *c*.

	INCH.
Length,	$\frac{1}{83}$
Height,	$\frac{1}{140}$
Thickness,	$\frac{1}{150}$

Carapace oblong oval, smooth, convex. *Dorsal and ventral borders* elliptical. *Extremities* rounded; *anterior* depressed, rather narrower than the *posterior*.

Dorsal aspect compressed ovate; *anterior* oval.

This little species has a somewhat similar form to that of *Cytherella truncata*, Bosquet, of the Chalk.[2]

One specimen from Byers' Quarry.

Order PHYLLOPA, *Latreille*, (?)[3]

Genus *Dithyrocaris*,[4] Scouler.[5]

ARGUS, *Scouler*, 1835.[6]

Gen. char.—*Thorax* protected by a carapace composed of two equal pieces that are connected more or less closely at the dorsal margins. *Tail* (abdomen) of animal protruding beyond the shell, having three caudal appendages.

[1] Syn. Char., &c., p. 168, pl. xxiii, fig. 25.

[2] Jones, Mon. Entom. Cret. Form., p. 30, tab. vii, fig. 25. Forms of carapace not very dissimilar to *C. inornata* and *C. nuciformis*, occur amongst the Cytheres from the Carboniferous Limestone of Kilbride, near Glasgow; a suite of which, with other microscopic fossils, is preserved in the Museum of the College of Surgeons of England. See p. 58.

[3] The relation that the fossil genus under notice bears to the other Entomostraca is as yet uncertain; it not being determined whether the carapace is truly bivalve, hinged, and closing on itself, or spread open, and liable to split in the mesial line. The Dithyrocarides were at first regarded by the discoverer as univalve Entomostraca, allied to Apus, but subsequently Dr. Scouler has been induced to look upon the carapace as bivalved, like that of Cypris, especially by the fact, as Dr. Scouler remarks, of the valves being often found separated, in which case it is probable that the mesial line is a hinge. The opinion, however, of these fossils having been univalved, i. e. of the valves having formed one unjointed whole, and presented a shield-like carapace, as in Apus and Limulus, is adopted by Col. Portlock (Geol. Rep. Londonderry, p. 314),—an opinion well supported by the appearance of *D. Colei*, and *D. orbicularis*, Portlock, and *D. Scouleri*, M'Coy. Indeed it is still a matter of doubt whether the fossil remains in question do not belong to more than one genus of Entomostraca.

[4] Etym. Δις, bis; θυρη, valva; καρις, squilla.

[5] See Portlock's Geol. Report Londonderry, p. 313.

[6] This name, having been preoccupied, was changed by Dr. Scouler to Dithyrocaris.

This interesting genus, first noticed by Dr. Scouler, in the 'Records of Science' for February 1835, was found by him in a Coal-measure Limestone near Paisley. At the meeting of the British Association at Glasgow, Dr. Scouler again described it under the name of Argus; but the generic characters have not yet been published in full. From the character and contents of the Limestone in which the specimens were imbedded, Dr. Scouler considers it probable that the Dithyrocarides found by him were the inhabitants of shallow and it may be fresh water.[1]

Two species from the Carboniferous beds have been figured and described by Colonel Portlock,[2] and two others by Prof. M'Coy,[3] from the same formation. On the Magnesian Limestone slabs, which furnished the Foraminifera and most of the Cytheres above described, there occur many specimens of the carapace-valves of *Dithyrocaris Permiana*, nob.; the majority, however, are in the condition of casts, more or less weather-worn. In the same stratum we have met with a unique specimen of *D. glypta*, nob.; but we have not recognised any of the caudal segments of either species. The same difficulty of extracting perfect specimens exists here as in the case of the other Microzoa of this rock; which is the more to be regretted, as certain characters of this genus have yet to be distinctly recognised. The relation of the valves to each other in the Carboniferous specimens seems constantly to be that described by Colonel Portlock,[4] viz. a horizontal parallelism; but we have found that in several instances, especially among the casts, the specimens apparently have their valves closed against each other, as in Cythere, instead of being spread out side by side, and in contact merely at their dorsal edges. This may be seen from the specimen, Tab. XVIII, fig. 1 *d*, in which one valve has been removed by weathering, and the edge of the other valve is apparent around the convexity of the cast. From such a cast, but more free from the matrix, the outline, Tab. XVIII, fig. 1 *c*, was taken, which, however, from its worn state, probably does not exactly give the original form.

Both of the Permian species are much smaller than those from the Carboniferous series; and *D. Permiana* especially differs from the usual type in being nearly bare of longitudinal ridges, which circumstance, together with the double-valved character of some of the specimens, led me at first to regard it as a Cythere of uncertain sub-genus.

[1] We are indebted to Dr. Scouler for a courteous communication on the facts connected with Dithyrocaris.

[2] Loc. cit.

[3] Synopsis Char., &c., p. 163, pl. xxiii.

[4] Loc. cit.

No. 1. DITHYROCARIS PERMIANA, *nob.* Tab. XVIII, fig. 1 *a*, *b*, *c*, *d*.

	INCH.
Length of carapace-valve,	$\frac{1}{26}$
Breadth —	$\frac{1}{35}$

Carapace-valve (left) oblong, convex, suddenly depressed along its anterior, posterior, and outer margins; bordered on its outer (left) edge by a slight ridge; smooth, faintly reticulated. *Dextral* (*dorsal*) *edge* nearly straight; *sinistral* straight in the middle, and curving off at each end to meet the dextral border. *Extremities* obliquely rounded; the *anterior*, in some specimens, almost squared; *posterior extremity of the dorsal edge* more acute than the *anterior*.

Internally the valves exhibit considerable thickness at the posterior extremity.

The valves of this species vary somewhat in the relative measurements of length and breadth, and sometimes the valves have an increased breadth posteriorly.

We have not met with a complete carapace; and entire valves are of rare occurrence; casts, however, more or less perfect, are very common at Byers' Quarry.

No. 2. DITHYROCARIS GLYPTA, *nob.* Tab. XVIII, fig. 12.

	INCH.
Length of carapace-valve,	$\frac{1}{23}$
Breadth —	$\frac{1}{50}$

Carapace-valve (left) oblong, convex, finely reticulated, bearing five curved longitudinal ridges. One ridge on the outer (left) border, and a second, a little within the first, extend from the junction of the dextral and anterior borders, following the curvature of the edge of the valve, to the posterior angle of the dextral border; the third and fourth ridges follow a like course, at equal distances, within the former ridges; the third ridge faintly marked posteriorly, and the fourth rather sinuous; a fifth ridge is placed a little to the right of the fourth, but is interrupted anteriorly. *Sinistral border of the valve* slightly incurved; *posterior extremity* obliquely curved, narrower than the *anterior*.

In this and the preceding species the angle of the anterior extremity of the dextral or dorsal border is more or less prominent, and not, as in other species, removed so as to form a large central notch when both valves are in juxtaposition.

From the same locality as the last.

Sub-kingdom MOLLUSCA, Cuvier.

Of the six great groups or classes into which this section of the Animal Kingdom is divided, viz. *Tunicata*, *Palliobranchiata*, *Lamellibranchiata* (ordinary bivalves), *Gasteropoda* (univalves), *Cephalopoda*, and *Pteropoda*, only two, the first and the last, are unknown as having existed during the Permian epoch.

Class Palliobranchiata, Blainville.[1]

Brachiopoda, *Dumeril*.
Polymaria, *Deshayes*.

Diagnosis.—"The Brachiopoda are defended by a bivalve shell, have two long spiral arms developed from the sides of the mouth, and respire by means of their vascular integument or mantle." (Owen.)[2]

With the exception of the *Tunicata*, the Palliobranchs or Brachiopods are generally considered as constituting the lowest class of molluscous animals. They have existed during all the organic periods of our planet; but have evidently been more numerous and more diversified in form in remote ages than at present. Only a few kinds are now living in the British seas.

Before describing the various genera and species of Palliobranchiate shells, to be noticed in this Monograph, it is proposed to enter into some particulars on the principal structures of the class in general.

Professor Owen having shown that, of the two valves with which a Brachiopod is provided, the large or perforated one, as in *Terebratula caput-serpentis*, stands in a direct relation to the ventral parts of the animal, that is, the principal nerves are given off from that side of the œsophageal collar nearest to it, and the mouth is turned towards it, while the hearts are situated nearest to the opposite one;[3] it necessarily follows, that the perforate valve should be distinguished by the name *ventral*, and the opposite or imperforate one by the name *dorsal*. Mr. Salter[4] has already used these terms in this sense; and they will be employed as such in the following pages, though not generally, as other terms can, in many cases, be more conveniently adopted.

The articulation of the valves is effected by a pair of teeth or condyles attached to

[1] Dict. des Sc. Nat., t. xxxii, p. 298, 1824.

[2] Lectures on the Comparative Anatomy and Physiology of the Invertebrate Animals, p. 269.

[3] Transactions of the Zoological Society, vol. i, part i; and Lectures on the Comparative Anatomy and Physiology of the Invertebrate Animals, p. 280.

[4] Memoirs of the Geological Survey, vol. ii, part i, p. 369.

the hinge of the rostral or perforate valve (Pl. XX, figs. 6 *a*, 10 *A*; Pl. X, fig. 8 *e*), and acting on a pair of sockets excavated in the hinge-plate of the opposite valve (Pl. XX, figs. 7 *a*, 11 *B*; Pl. X, fig. 8 *f*).

In many genera the teeth are attached to a pair of plates (Pl. X, fig. 8 *a*), which, in the phraseology of Von Buch, are called "les lamelles de soutien des dents;" an expression which may be conveniently rendered into *dental plates*. The dental plates are nearly perpendicular in *Cleiothyris pectinifera*: they approximate more or less to each other at their superior margin in *Trigonotreta*, and some other genera (Pl. X, fig. 28 *a*); in *Pentamerus*, *Orthisina*, *Camerophoria* (Pl. VIII, fig. 3 *a*), they conjoin superiorly, forming an arch-shaped process more or less acute; while in *Leptæna* (Pl. XX, fig. 6 *b*) this process is so far modified as to become saucer-shaped. The dental plates, whether conjoined or separated, vary greatly in length: in *Camerophoria*, *Cleiothyris*, and some others, they do not pass far into the cavity of the shell; in *Pentamerus* they extend to a considerable distance; while in *Trigonotreta Mosquensis* they are prolonged nearly to the frontal margin of the valve to which they are attached.[1]

In certain genera, as *Pentamerus* and *Camerophoria*, the arch-shaped process is attached by its crest to the medio-longitudinal line of the *ventral* or rostral valve, by means of a vertical plate directed forward from the point of the beak (Pl. VIII, figs. 3 and 4 *b*). The *ventral median plate*, for such this last part may be termed, is seen independent of the dental plates in *Delthyris cristata* (Pl. VIII, fig. 18 *a*), and without them in *Strigocephalus* (Pl. XIX, fig. 1 *a*): it is protruded within the arch in *Spirifer heteroclytus*, and within the saucer-shaped process in *Leptæna analago* (Pl. XX, fig. 6 *c*). The ventral median plate evidently subserves different purposes in different genera: it supports the arch in *Pentamerus* and *Camerophoria*, and answers as a muscular fulcrum in *Delthyris*, as proved by the scars which I have seen on it in a beautiful specimen of *D. octoplicata* in the possession of Mr. T. Davidson. The central vertical plate or muscular support in the attached valve of *Criopus*, is perhaps its homologue; and the same may be suggested of the broad, elevated ridge covered with muscular scars to be seen in the medio-longitudinal region of the large valve of certain species of *Productus*. The singular process, in the form of a shoe-lifter, described in my paper on the "Palliobranchiata,"[2] as occurring in the large valve of *Cleiothyris concentrica*, and which is seen in another allied species from Bohemia, in Mr. Davidson's collection, I am disposed to think is a modified form of the ventral median plate.

Passing to the opposite or dorsal valve, the cavities in the hinge-plate serving as sockets for the teeth, or, in other words, the *dental sockets*, are each bounded inwardly by a ridge, which occasionally becomes somewhat prolonged, passing into the cavity of the shell (Pl. XX, fig. 11 *C*). The *socket-ridges* are seen in *Delthyris cristata*

[1] Vide Geology of Russia, vol. ii, pl. v, fig. 2 *b*, *d*.

[2] Annals and Magazine of Natural History, vol. xviii, p. 86.

(Pl. VIII, fig. 10 *a*), *Streptorhynchus pelargonatus* (Pl. X, fig. 28 *b*), *Orthis eximia*,[1] and *Strigocephalus Burtini* (Pl. XIX, fig. 1 *b*). They are also characteristic of Pentamerus, and that curious group of shells hereafter noticed under the name of *Isorhynchus*.

The socket-ridges, at their junction with the hinge, are often seen approximating towards each other: in some cases they remain separated, as in the Crag *Waldheimia variabilis;* but in general they conjoin, and form either a horizontal plate, as in *Cleiothyris pectinifera* (Pl. X, fig. 9 *a*), and *Camerophoria multiplicata* (Pl. VIII, fig. 5 *c*), or a concave one, as in *Waldheimia Australis* (Pl. XX, fig. 11 *D*), and *Epithytris elongata* (Pl. VI, fig. 45 *b*). Besides another use, hereafter to be noticed, which this plate evidently serves, it forms the base of what are called the "crura of the loop" (Owen); it may therefore be termed the *crural base*.

The crura of the loop are two slender processes, which start from the crural base, and project into the cavity of the shell, becoming attached, in *Terebratulidæ*, to a slender, recurved or simply-folded, testaceous apparatus, known under the name of "*the loop*" (Pl. VI, fig. 45 *e*; Pl. XX, fig. 12 *F*); and, in *Spiriferidæ*, to a pair of spirally-folded appendages.[2] The two long, slender processes springing from the crural base in *Strigocephalus Burtini* (Pl. XIX, fig. 1 *c*), and curving up to the ventral median plate, may safely be considered as the crura. These processes, however, are not always thus attached; since they are free in *Hypothyridæ*, as exhibited in the illustrative figures of *Camerophoria* (Pl. VIII, figs. 3, 4 *g*).

Professor Owen, from his observations on certain Palliobranchs, was led to conclude that the crura supported the visceral parts of the animal, and that the loop and the spirals afforded attachment to a pair of ciliated appendages originating from each side of its mouth; but in *Terebratula caput-serpentis* the loop chiefly supports the viscera, inasmuch as the oral or labial appendages are, for the most part, free, projecting in this condition, and recurving considerably in front of the loop. In *Hypothyris psittacea*, which has neither a loop nor spirals, the labial processes are also free except at their origin.

The loop is variously modified in Terebratulidias. In the typical genus, *Terebratula* (*caput-serpentis*), and in *Gryphus* (*vitreus*), it is somewhat ring-shaped, and simply attached to the crura; in *Waldheimia* (e. g. *Australis*, vide Pl. XX, fig. 11 *F*) it is similarly attached, and with its free end bent back to nearly the crura; in *Epithyris* (vide Pl. VI, fig. 45 *e*) it is attached in the same way, but its anterior part is only slightly recurved; in *Terebratella* (*Chilensis*) and *Megerlia* (*dorsata*), it is joined both to the crura and, at the anterior end, to a plate running along the medio-longitudinal line of

[1] Geology of Russia, vol. ii, pl. xi, fig. 2 *d*, *e*.

[2] Professor M'Coy, in his 'Synopsis of the Characters of the Carboniferous Limestone Fossils of Ireland,' p. 127, fig. 15; and Mr. T. Davidson, in the 'London Geological Journal,' vol. i, have given the best illustrations of the spiral coils of *Spiriferidæ*: they are represented, but without being attached to the crura, in Pl. X, fig. 10, and Pl. IX, fig. 8.

the imperforate valve; it is also to be seen both posteriorly and anteriorly attached in *Magas pumilus*;[1] while in the singular *Pachyrhynchus roseus* it is simply united to the anterior end of a corresponding plate; whereas in *Terebratula* (?) *Natalensis* it seems to be reduced to two erect processes springing from the centre of the imperforate valve.

Perhaps the loop, in no case, exists under so enlarged a form as in *Strigocephalus Burtini*,—a shell on which I feel it necessary to make a few observations corrective of what I have elsewhere stated respecting its internal structure.[2] Having lately succeeded in exposing the interior of a specimen, which for a long time defied all my efforts to disclose, I am now enabled to state, that the internal structure of this species does not consist of two parts folded, so as to form a pair of "symmetrical subgyrate appendages," as I formerly stated; but it is in reality a single piece, having a tolerably close agreement with the loop of certain *Terebratulidæ* (Pl. XIX, fig. 1 *d*). The crura have certainly an unusual peculiarity; their modification from the ordinary form, however, is not difficult of explanation. Shorten the ascending stems (*c*), and conjoin them with the descending portions of the loop (*d*),—the resulting form will be precisely the same kind of projecting crura seen in Pl. VI, fig. 45 *e*, and Pl. XX, fig. 12 *E*.

The figures which M'Coy and Davidson have given of the spirals or labial supports of *Delthyris* and *Trigonotreta*, show very clearly that they are connected with the crura, and these again with the crural base near the socket-ridges, as in *Terebratulidæ*; and it affords me much pleasure in finding my own observations on the spirals of *Delthyris cristata* fully corroborating their representations.

The imperforate or small valve of many genera has a plate holding a position similar to the one already noticed, running along the medio-longitudinal line of the opposite valve (Pl. XIX, figs. 3 *b*, &c.). To distinguish this plate from the latter, it is proposed to term it the *dorsal median plate*. In *Waldheimia Australis* (Pl. XX, fig. 11 *G*) and several other species, it supports the crural base; in *Camerophoria multiplicata* (Pl. VIII, figs. 3, 4 *f*) it steadies a spatula-shaped process, which will hereafter be described; and in *Magas pumilus* it affords support, at its anterior end, to a modified form of a probably homologous structure; but in *Productus* (Pl. XI, fig. 10 *b*), which has neither a crural base nor loop, its use appears only to keep certain muscles separated from each other. The dorsal median plate apparently subserves the latter purpose in *Leptæna* (Pl. XX, fig. 7 *b*), and some other shells; but in another form, *Strophomena Dutertrii*, there seems to have been a failure in this respect, since the muscles were implanted on lamellar fulcra, which curve over it, and coalesce, forming, as it were, a complete arch.

[1] Vide Note sur le Magas pumilus, par MM. Th. Davidson et Bouchard-Chantereaux, Bulletin de la Soc. Géol. de France, 2me série, tom. v, pp. 139-41, pl. ii.

[2] Annals and Magazine of Natural History, vol. xviii, p. 88.

Attached to the hinge of both valves of *Spirifer, Strophalosia, Leptæna, Orthis,* and some other genera, is a flat part, usually termed the *area*, approximating more or less to a position at right angles to the plane of the hinge-plate (Pl. XIX, fig. 6 *a*, *c*; Pl. XII, fig. 19 *a*, *c*; Pl. IX, fig. 1*a*; Pl. XX, figs. 6*j*, 7*g*). It is generally deepest in the perforate or corresponding valve; the exception being in *Strophomena euglypha*, and a few others. In certain *Terebratulidæ*, such as *Delthyridæa* (e. g. *pectiniformis*), the area is equally visible; and there can be little doubt that the flattened space on each side of the foramen in the perforate valve of some of the Jurassic Hypothyrises is a modified form of the same part.

In most of the dentigerous Palliobranchs a triangular opening intervenes between the teeth of the large valve (Pl. IX, figs. 1 *b*, 12 *a*) and the dental sockets of the other (Pl. IX, fig. 7 *b*); this it is proposed to term the *fissure*,[1] which is equivalent to the "deltidium" of my former paper. I make this alteration to meet the views of several parties who are desirous of seeing the term *deltidium* restricted to the part to which it has been applied by Von Buch and M. de Verneuil; this term will therefore be used in the following pages for the simple or bipartite piece often seen occupying the fissure, and which I formerly named the "cicatrix." The fissure is *closed* in many shells by the deltidium, as in *Strophalosia Gerardi* (Pl. XIX, fig. 6 *b*), *Streptorhynchus pelargonatus* (Pl. X, fig. 24 *a*), and *Strophomenæ* generally; and *open* in others, for example, *Trigonotreta* (Pl. IX, figs. 1 *b*, 12 *a*), *Hypothyris psittacea*, and *H. excavata*. It is *concealed* in most Cleiothyrises, and *exposed* in Spiriferidias and Leptænas; while in certain genera, it exists under both conditions; for example, it is concealed in *Pentamerus galeatus*, and exposed in *P. conchidium;* moreover, in *P. Knightii*, it is exposed in a young state, and closed at a later period. The fissure, with or without the deltidium, does not always coexist with the area; since the latter is not associated with the (open) fissure in Hypothyrises (*H. psittacea*), or in *Camerophoria Schlotheimi* (Pl. VII, fig. 13 *a*); nor is there an area coexisting with the closed fissure in *Waldheimia Australis* (Pl. XX, fig. 10 *I*).

In *Terebratulidæ* and *Siphonotreta* generally, and in certain Strophomenas, Leptænas and Palæozoic Hypothyrises, the umbonal region is furnished with an aperture usually of a circular form, and termed the *foramen*. It is *apical* when situated at the point of the beak, as in *Waldheimia Australis* (Pl. XX, fig. 10 *H*), *Epithyris sufflata* (Pl. VII, fig. 7 *a*), and *Hypothyris marginalis*, Dalm.; *sub-apical* when placed below the point, as displayed in most of the secondary Hypothyrises; and *supra-apical* when situated above the point, as in *Leptæna analoga* (Pl. XX, fig. 6 *e*). It is interrupted inferiorly by the fissure in *Cleiothyris pectinifera* (Pl. X, fig. 3 *a*) and *Terebratula caput-serpentis*, in which case it may be termed an *emarginate foramen;* when its outline is complete, as in *Waldheimia*

[1] The binomial epithets, "triangular opening" (De Verneuil) and "deltidial area" (Morris), are objectionable, both as not being succinct enough: the latter is still more so, as one of its members (*area*) is already current for another cardinal structure; a circumstance liable to induce confusion.

Australis and *Leptæna analoga*, it may be designated an *entire foramen*. It is entire and apical in *Waldheimia Australis;* in *Leptæna analoga* it is entire and supra-apical; in *Hypothyris obsoleta*, entire and sub-apical; and in *Cleiothyris pectinifera* and *Terebratula caput-serpentis*, emarginate and apical.

The distinction between a foramen and a fissure is indispensable, as the former appears to have served in all cases as an opening for a pedicle, by which the Palliobranchs possessing it were attached to foreign bodies; but the latter structure, even when open, did not always occupy this office, as proved by the presence of a supra-apical foramen in *Leptæna analoga*, and the fissure being completely occupied by a prominency situated in the centre of the hinge-plate of the opposite valve. Besides, in *Orthisina adscendens* and *Spirifer heteroclytus*, which have the fissure closed by a deltidium, this last structure is furnished with a foramen. It must be admitted, however, that an open fissure, in the absence of a foramen, must have served as a passage for the pedicle; and it is evident, when a fissure became filled up by the deltidium, and conditions rendered it still necessary for the shell to remain attached, that a provision was made for the contingency by the addition of a foramen in the most suitable place.

Increase of age evidently induced, in some instances, a modification of the structures under consideration: thus *Strigocephalus Burtini*, in the young state, is furnished with an open fissure, like that of *Spiriferidæ;* it is afterwards closed by a deltidium, which, however, is furnished with a true foramen, as in *Orthisina adscendens*, but it is suspected that the foramen also became completely closed at the final period of growth. From what M. de Verneuil states respecting the last shell,[1] it appears to be subject to a similar modification; but in this instance the modification has the appearance of being merely varietal, and not apparently specific, as in *Strigocephalus*.

The foregoing will tend to clear up certain discrepant statements which have been published on the structure last noticed—one writer describing a shell as perforated, and another stating it to be imperforate: thus *Spirifer heteroclytus* is in this predicament. A specimen of *Cleiothyris Roysii*, at present before me, exhibits a distinctly-defined, incomplete, apical foramen; yet there are several who state that it is imperforate: it is the same with some other species of this genus. The mutability of nearly all the hinge-characters is curiously displayed in Rhenish specimens of *Atrypa reticularis:* in some there is no appearance of a foramen; in others it is distinctly visible: again, in one the foramen is entire and apical; in a second, sub-apical and entire; in a third, apical and incomplete; and in a fourth, sub-apical and incomplete: some specimens are even provided with a distinct area. So liable is the foramen to become closed, that it seems unsafe to reject a specimen from any given perforated species, because it is imperforate. I have specimens of *Leptæna rhomboidalis* from the Eifel, with a distinct supra-apical foramen, but neither my Malvern nor Swedish specimens

[1] Geology of Russia, vol. ii, p. 204, pl. xii, fig. 3.

of corresponding size of the same species exhibit any trace of this structure.[1] As already observed, the foraminated deltidium of *Orthisina adscendens* does not appear to be general in the species. It will thus be understood, that I am little disposed to agree with M. Alcide d'Orbigny[2] in making the foramen in *Strophomenidæ* a generic character.

Most of the palliobranchiate genera are furnished with a prominency, more or less developed, in the centre of the hinge of the small or imperforate valve (Pl. VI, fig. 45 *d*; Pl. VIII, figs. 3, 5 *d*; Pl. XI, figs. 10 *a*, 11, 12; Pl. XIX, fig. 3 *a*; Pl. XX, fig. 7 *e*). This *boss*, as in future it will be termed, exists under various forms in different genera; it is very small in *Cleiothyris pectinifera* (Pl. X, fig. 9 *c*); rounded, and a trifle larger in *Camerophoria multiplicata;* about the same size, and cup-shaped in *Waldheimia Australis* (Pl. XX, fig. 11 *J*); larger, and bisected in *Leptæna analoga* (Pl. XX, fig. 7 *e*); still larger, and bi- or trilobed in *Productus horridus*, (vide Pl. XI, figs. 11, 12), and some other genera; elongated, and somewhat erect in *Orthis eximia*,[3] and some species belonging to the Cretaceous system; and drawn out, assuming a nearly horizontal position on a thick cardinal plate in *Bouchardia rosea*. In *Trigonotreta undulata* (Pl. IX, fig. 7 *b*), *Hypothyris psittacea*, and many other shells, the boss does not exist; while, on the other hand, it is enormously developed in *Strigocephalus Burtini* (Pl. XIX, fig. 1 *e*), forming a massive, curving process, stretching from the hinge to nearly the centre of the opposite or large valve, where it clasps, as it were, the ventral median plate by means of its dilated bifurcated extremity. These modifications will show that the boss has not served as a tooth or an articulating instrument, as is generally considered; the cavities (sockets) on each side of it, and their occupying parts, were the only structures adapted for this purpose. As will afterwards be shown, the boss served as a fulcrum for certain muscles; but it may be observed, in the present place, that its non-articulating character is clearly proved by the markings usually displayed on its surface in *Productus* (Pl. XI, fig. 11) and *Leptæna* (Pl. XX, fig. 7 *e*), and by the complete absence in the hinge of the opposite valve of a correspondingly marked depression in which it could act.

The muscular system of the Palliobranchs may now be described. With perhaps but few exceptions, the umbonal cavity of a brachiopod shell is furnished with a dense, fibrous, cylindrical body, termed the *pedicle*. In *Waldheimia Australis* the inferior end of the pedicle fits into the foramen (Pl. XX, fig. 12 *a*), and its superior end, which is somewhat flattened or dilated in the transverse direction of the shell, is situated at the entrance or anterior part of the rostral cavity, to the surface of which it appears to be attached by means of tendinous or membranous chords; the truncated extremity of the pedicle itself apparently not being adherent. There is one genus,

[1] Mr. D. Sharpe has found a "foramen in some young specimens" of the same shell from the Wenlock Slate. (Vide Quarterly Journal of the Geol. Soc., vol. iv, p. 172.)

[2] Comptes-rendus de l'Acad. des Sc., vol. xxxvi, 5 Août, 1847.

[3] Geology of Russia, vol. ii, p. 192, pl. xi, fig. 2 *e*.

Productus, which, on account of its never displaying either a foramen or fissure, might be supposed to be unprovided with a pedicle; but as this part, as will shortly be seen, affords attachment to several muscles, it seems unsafe to predicate its absence in any palliobranchiate genus whatever, but particularly in one intimately related to forms (e. g. *Strophomena* and *Leptæna*) which undoubtedly possessed it.

The pedicle may be said to serve two purposes: *first*, the mooring of the shell to foreign bodies; and, *second*, as a muscular fulcrum. In the imperforate Strophomenas and Leptænas it can only have occupied the latter office, since the fissure is either closed with a deltidium, or completely filled up with the boss of the opposite valve; but in the perforated species, as *Strophomena alternata*, *Leptæna analoga*, &c., it is clear that the pedicle has served both purposes. The simple office, that is, its answering as a base of attachment for certain muscles, is the one I propose assigning to the pedicle of *Productus*. The same simple subserviency of the pedicle is evidenced in the non-foraminated Orthisinas (*O. plana*, *O. hemipronites*) and Strophomenas (*S. rugosa* = (?) *planumbona*); while it is duplicated in such congeneric species as *Strophomena alternata* and *Orthisina Verneuili*. From the foramen becoming closed in old shells, it must be concluded that the pedicle, as a mooring instrument, was dispensed with in old age: my large specimens of *Leptæna analoga* show the foramen distinctly closed. In young examples of *Strigocephalus Burtini* the pedicle passed through an open fissure, as in many Spiriferidias; in individuals of a more advanced age, it passed through a foramen in the deltidium, which had gradually filled up the fissure; while in those full grown, it was dispensed with, as proved by the filling up of the foramen as well.

In the perforate valve of *Waldheimia Australis* three pairs of muscles pass from the inside, a little in advance of the upper end of the pedicle, to different situations. The outermost pair, which consists of the muscles implanted nearest the sides of the valve, passes at a slight angle into the upper part of the pedicle (Pl. XX, figs. 10, 12 *b*). Within these muscles, and somewhat in front of them, another pair (Pl. XX, figs. 10, 12 *c*) passes downwards, slightly converging at the same time, and becomes attached to the boss on the hinge of the imperforate valve (Pl. XX, figs. 11, 12 *J*). To distinguish these two pairs of muscles from each other, it is proposed to name the former the *superior pedicle muscles*, and the latter the *cardinal muscles*.

A little in front of the superior end of the pedicle, and a little behind and within the attachment of the cardinal muscles, and therefore near the medio-longitudinal line of the perforate valve, is implanted the remaining pair, which passes directly down to a little behind the centre of the imperforate valve; each muscle, at the same time, becoming dichotomous in its inferior half (Pl. XX, figs. 10, 12 *d*): these may be termed the *valvular muscles*. In addition to the cardinals and the valvulars, the imperforate valve affords attachment to other two muscles, which pass upwards from

the crural base (where each one is divided), and become inserted in the upper part of the pedicle (Pl. XX, figs. 10, 12 *e*): it is proposed to name these the *inferior pedicle muscles.*

From an examination of a number of palliobranchiate shells, I feel persuaded that a muscular system similar to that of *Waldheimia Australis* characterised the genera *Productus*, *Leptæna*, *Orthis*, and several others. In the large or corresponding valve of these shells, there are impressions answering to the six muscles which have been described as passing from the perforate valve; and in the opposite valve there are impressions answering to the four inferior divisions of the valvulars; and the hinge is either furnished with a boss or an excavated part (Pl. IX, fig. 7 *b*), having a surface displaying evidence of muscular attachment.

I am not decided as to the existence of impressions in any of the fossils named, resulting from the inferior pedicle muscles, that is, those passing from the crural base to the upper part of the pedicle; indications of something of the kind are, however, observable on sharp casts of *Productus horridus* (Pl. XI, fig. 10 *c*); and I am inclined to think that the marks occasionally seen on the socket-ridges of *Schizophoria Michelini* are due to these muscles. Considering the faintness of the impressions of the inferior pedicle muscles in *Waldheimia Australis*, it need not be a matter of surprise how few and slight the indications of their presence are in specimens found in a fossil state.

The impressions just noticed are best seen on casts of certain species of *Productus*. Guided by the muscular system of *Waldheimia Australis*, I am led to conclude that the two large striated impressions on the convex valve of *Productus giganteus* (Pl. XIX, fig. 2 *a*) are due to the superior pedicle muscles: the linear impressions often observable converging from them towards the umbone, show that the muscles belonging to them have been in close contact with the inner surface of the large valve: this circumstance, their size and position relatively to the adjoining muscular impressions, constitute a powerful argument in favour of the view stated.

Within the impressions of the pedicle muscles, and on a flattened elevation, are situated four other impressions (Pl. XIX, fig. 2 *b*, *c*; vide explanation of Pl. XIX): they are often undefinable and confluent (Pl. XI, fig. 15 *b*; Pl. XII, fig. 3 *a*); but occasionally specimens exhibit them separated. The peculiar dendritic character of these impressions has induced many to conclude that they were produced by the viscera; but from the fibres of the muscles of *Waldheimia Australis* possessing a dendritic arrangement, and thereby being capable of producing similar impressions under proper circumstances, this view has been materially divested of the principal argument adduced in its favour. The stopper muscle of *Anomia ephippium* produces a similar dendritic impression (Pl. XX, fig. 8 *a*). The three pairs of impressions to be seen on the saucer-shaped process in the perforate valve of *Leptæna analoga* (Pl. XX, fig. 6 *f*, *g*, *h*) may also be referred to the pedicle, cardinal, and valvular muscles, since they hold nearly the same relative position as those of *Productus giganteus.*

Two of the four impressions under consideration (probably the anterior pair) I consider to be due to the valvulars, and the others to the cardinals. The former muscles, according to this view, have necessarily produced the dendritic impressions generally to be seen on the flat or opposite valve adjoining, and on each side of, the median plate (Pl. XI, fig. 10 *c*, *d*; Pl. XIX, fig. 3 *c*, *d*)—a conclusion demonstrated by the impressions being divisible into two pairs, as in *Waldheimia Australis* (Pl. XX, fig. 11 *f*, *g*); and their agreement, in this respect, with what have never been otherwise than looked on as muscular impressions in *Trigonotreta* (Pl. IX, fig. 6 *a*, *b*), *Leptæna* (Pl. XX, fig. 7 *c*, *d*), and several well-known species of *Orthis* and *Strophomena*.

Sufficient has already been advanced in proof of the boss on the hinge of the small valve of *Productus* being a muscular fulcrum; but to which pair of the four central muscular impressions on the opposite valve it was related, is far from clear; should it prove correct, however, that the anterior pair was produced by the valvulars, it will follow that the posterior pair has been caused by the cardinals.

Thinking that a restoration of the myology of *Productus* would be acceptable, I have been induced to give representations of it under figures 4 and 5, in Plate XIX, which will also tend to render intelligible the foregoing observations. A reference to the explanation of the figures on the page opposite the plate containing them will conveniently make known the various muscles as restored in accordance with the views brought forward.

There is one peculiarity which must not be overlooked in a consideration of the muscular impressions of the Brachiopods; namely, their liability to become changed into projecting apophyses. In young specimens of *Leptæna analoga* the muscles of the large valve have evidently been implanted in a shallow excavation in the substance of the shell; but in full-grown specimens the excavation has become modified into a saucer-shaped process, strikingly resembling the convex valve of a *Strophomena*, being marked on the side facing the inner surface of the valve, to which it is attached, with fine, radiating, somewhat distant lines. A similar modification is to be seen in various species of *Strophomena*. In the rostral valve of certain Schizophorias and Orthisinas, the muscular impressions are situated on a flattened space between the dental plates; in others this space is considerably narrowed by the approximation of the dental plates at their superior margin; while in a few it has completely disappeared, through the dental plates coalescing, and forming an arch-shaped process, as in *Camerophoria* and *Pentamerus*,[1] which process, in all shells provided with it, must be regarded as a true muscular fulcrum. In the opposite valve there is a similar tendency to modification displayed, though not so often. It is evidenced in Leptænas; singularly so in the base of the arched plate already noticed in *Strophomena Dutertrii*; and, as will be hereafter shown, it has induced the formation of the spatula-shaped process, already noticed

[1] Fossils showing these modifications are beautifully represented in plates xi and xii, vol. ii, of the Geology of Russia.

in *Camerophoria*. I am only acquainted with the internal structure of *Magas pumilus* through the beautiful figures given of it by Mr. Davidson;[1] I can therefore only throw out the suggestion that the anterior part of the apophysis of this shell may also be a muscular fulcrum.

One of the features which distinguish the Palliobranchs as a class from all other molluscs, is their branchial system. Instead of possessing a respiratory apparatus, in the shape of laminated gills, as in ordinary bivalves, both lobes of the mantle are rendered subservient to respiration, by means of numerous veins and arteries variously and minutely ramifying towards the pallial margin.[2] All the recent forms hitherto examined, have the mantle closely and strongly adhering to the inner surface of the valves; and, it is in consequence of this adhesion, that we occasionally meet with palliobranchiate fossils displaying, in the most beautiful and instructive manner, impressions of the vessels that conveyed the blood which circulated in the long-since extinct molluscs that inhabited them.

Having succeeded in obtaining several specimens exhibiting impressions of nearly their entire vascular system, it has been deemed necessary to give some figures to illustrate a character of the greatest importance in the class under consideration. The figures representing casts of both valves of *Camerophoria multiplicata* (Pl. VIII, figs. 6, 7) instructively display the large veins (*i*) or returning vessels inclosing the arteries (*j*), described by Professor Owen as prevailing in the recent forms.[3]

The specimens of *Leptæna analoga* represented under figures 6 and 7 in Plate XX, show the impressions of the vascular system in a beautiful state of preservation; but owing to the veins being obscured and confused near the anterior angles of the valves, it is impossible to say whether the main trunks passing along their medio-longitudinal region curve continuously round towards the centre of the hinge, or become confluent, where the obscurity prevails, with those which pass along, and forward from, the hinge-line, supposing the latter to originate in the medio-cardinal region. From what is displayed on the figures of *Camerophoria multiplicata*, the former view seems to be the correct one. The cast of *Trigonotreta undulata*, under figure 6 of Plate IX (*c*), is the only specimen of the genus I have seen exhibiting the vascular system.

Besides the vascular and muscular impressions, there are others, in certain genera, to which it is necessary in the next place to direct attention. The flat valve of *Productus* often exhibits two reniform impressions or lobes, each one striking off from between the pair of muscular scars situated on each side of the median plate (Pl. XI, fig. 10*f*; Pl. XIX, fig. 3*f*),—an origin, which, to a certain extent, identifies them with the primary vascular trunks, issuing in a similar way (and occasionally subdividing into

[1] Note sur le Magas pumilus; Bull. de la Soc. Géol. de France, 2^{me} série t. v, pl. ii.

[2] In *Lingula* the branchial system is somewhat modified.

[3] Transactions of the Zoological Society, vol. i, part ii.

smaller vessels), in *Strophomena alternata*,[1] *Atrypa reticularis*,[2] *Orthisina Verneuili*,[3] and *Leptæna analoga* (Pl. XX, fig. 7 *f*).

Many palæontologists suppose the reniform lobes to be due to the labial appendages. One very strong argument, however, against their being considered in this light, is in the fact that labial appendages are not pallial organs: they are parts existing independently of, and between, the lobes of the mantle. Now the organs that have produced the reniform impressions it is difficult to conceive to have pertained to anything else but the mantle; in short, to have been otherwise than true pallial organs. Originating as they undoubtedly do in the same place as the primary vascular trunks in the fossils just named, that is, between the scars of the divided extremities of the valvular muscles, is both a direct and conclusive evidence in favour of this view; and it may be said to be still further supported by the fact next to be brought forward.

In both valves of the family *Craniadæ* there are two large dilated impressions, either in relievo or intaglio, passing singly out from between two muscular scars situated on each side of the median line, and in their course following the anterior curvature of the shell, and terminating at a little distance short of the centre of its anterior half. These impressions vary in form in different species. In *Crania costata* they are simple, as in the above description; while in *Criopus turbinatus* (Pl. XX, fig. 9 *a*), and some others, they become digitated on the outside; in all known species, however, the main features of these impressions are, their originating between the lateral muscular scars, their sweeping round to the front of the shell, and their dilated form—features closely identifying them with the reniform lobes of *Productus*.

Comparing the slender, complex, ramified, vascular markings of *Camerophoria* and *Leptæna* with the dilated and simple impressions of *Crania costata*, there seems room to warrant their advocated homology being demurred to until some other evidences are adduced.[4]

When either valve of *Criopus anomalus* is examined, it is seen exhibiting a pair of digitated impressions similar in form to those of *C. turbinatus;* and on examining the animal of the same shell, each lobe of the mantle is observed to be furnished with two vascular structures of a perfectly corresponding form, and crowded either with the ovaries or testes, clearly proving that the former have been caused by the pressure of vessels loaded with the reproductive organs. Coupling this fact with the similarity both of form and origin of the reniform lobes of *Productus* with the impressions of *Crania*, particularly those of *C. costata*, and considering the conclusion already arrived

[1] Davidson, Mém. sur les Brach.; Bull. de la Soc. Géol., 2^{me} série, t. v, pl. iv, fig. 1 *b*.

[2] Op. cit., pl. iii, fig. 35.

[3] Geology of Russia, vol. ii, pl. xii, fig. 1 *b*.

[4] Probably it was the differences here indicated which led Goldfuss and others erroneously to conclude the impressions of *Crania* to be the production of the labial appendages.

at, when comparing the former with the vascular impressions of *Leptæna* and *Orthis*, there seems little remaining to prove that the pallial structures, to which the production of the reniform lobes of *Productus* have already been assigned, were the genito-vascular organs of the animal.

Seldom have any other traces than the reniform lobes been discovered of the vascular system of *Productus*. Dr. de Koninck, in his 'Animaux Fossiles,' figured the large valve of a species exhibiting, as he thought, impressions of vessels ramifying over its surface; later observations, however, have convinced him that these impressions have been caused by an Annelid.[1] A considerable number of specimens have passed under my observation, with the view of ascertaining the existence of vascular impressions, but, with one exception, the only appearance of the kind I have seen is on the flat valve of a *Productus setosus*, kindly given me by Mr. G. Tate, who procured it from the Carboniferous shales in the neighbourhood of Alnwick. What are taken for vascular impressions are two main trunks, each one laterally situated, running near the sides of the valve, and giving off outwardly, and at regular distances, numerous simple branches, which loose themselves in the margin. The specimen of *Productus giganteus* under figure 2, Plate XIX, may also be noticed as showing very distinctly one or more vascular impressions (*d*) originating in the region of the medial dendritic scars; and in their course repeatedly subdividing, and finally passing into the large striated lateral impressions: the producing vessels of these impressions have undoubtedly nourished the superior pedicle muscles.

Reverting to the labial appendages, it would scarcely be concluded, considering the soft and extensile nature of these organs in *Hypothyris psittacea*, that they had ever left any traces of their existence in shells which had neither spirals nor a loop to support them; the rigidness and immobility of the labial appendages in certain existing genera, for example, *Discina*, *Criopus*, and *Terebratula* (e. g. *caput-serpentis*), in which there is no appropriate apophysary system,[2] warrant us, however, in cautiously weighing all observed facts before assenting to this conclusion. The facts in question are certain impressions occasionally met with in *Productus*, and which it is proposed to refer to the pressure of the labial appendages; it is in this view we must regard the pair of somewhat concentrically-furrowed hollows occasionally to be seen on the inside of the large valve of these shells, or the correspondingly marked prominences often displayed on casts of the same. M. Von Buch, who first brought forward this view, has already figured a specimen in the latter state; and I have been fortunate in obtaining another one showing similar characters (vide Pl. XIX, fig. 2 *e*). In their position and form, these impressions forcibly remind one of the horizontal, spirally-folded, labial processes of *Discina* and *Criopus*. It may be noticed, in passing, that if the reniform lobes on the flat valve of *Productus* had sustained the labial appendages,

[1] Monographie du genre Productus, 1847.

[2] The loop in *Terebratula caput-serpentis* is mainly a visceral support.

the impressions just noticed ought to be immediately opposite to them. I can safely assert, however, that this is not the case in *Productus horridus*, as I have now examined a number of perfect casts of this species, and in all of them the latter are always considerably behind the former.

But perhaps no shell exhibits impressions of the labial processes so distinctly as the remarkable valve figured by M. de Verneuil in the 'Geology of Russia' (vol. ii, pl. xvi, fig. 9), in which the impressions, occupying its two lateral halves, are in the form of two depressed cones, having their surface strongly marked with five or six spiral grooves, gradually rising above each other from the base to the apex.

A single other reference may be allowed before drawing the present subject to a conclusion. The indisputable existence of horizontally-spirally-folded labial appendages in *Productus* prevents my instituting a comparison between its reniform impressions and the singularly complex furrows on the flat valve of *Thecidæa Mediterranea*; because, from the observations of M. Alcide d'Orbigny,[1] it would appear that this interesting Palliobranch does not possess any labial processes *spirally folded* as in *Productus*. If M. d'Orbigny's view be correct,[2] this shell possesses the homologues, though certainly singularly modified, of the *recurved* labial appendages characteristic of Ancylopods.

Since the publication of my 'Remarks on certain Genera of the Class Palliobranchiata,' there have appeared in various journals some highly valuable communications,[3] which have thrown so much important light on the classification of this division of molluscous animals, that I have been enabled to make several corrections and alterations in the following Synoptical Table, as compared with the one contained in the above-named paper.

As regards a Fundamental Classification of the group, I feel much pleasure in adopting Mr. J. E. Gray's, as it is based on a modification of an important organic structure,—a modification which is, at the same time, manifested by a corresponding variation of the apophysary system.

[1] Vide Annales des Sciences Nat., Oct. 1847.

[2] I would suggest in all new examinations of *Thecidæa Mediterranea*, that its furrows be compared with the digitated crania-like impressions of *Thecidæa digitata*; and that a comparison be made between the organs occupying the furrows with the branchiferous vessels of *Lingula*.

[3] It is necessary to mention that Mr. Morris's paper 'On the Subdivision of the Genus *Terebratula*' (vide Quarterly Journal of the Geological Society, vol. ii, part ii, p. 382-9), in which he took nearly the same view of the genus *Hypothyris* as the one published by myself, was communicated to the Geological Society at the time my own paper in the 'Annals and Magazine of Natural History,' vol. xviii, 1846, was going through the press.

CLASSIFICATION OF THE VARIOUS GROUPS CONSTITUTING THE CLASS PALLIOBRANCHIATA.

SUB-CLASSES.	ORDERS.	FAMILIES.	GENERA.[1]
HELICTOPODA.	*Sarcicobrachia*.	Lingulidæ	Lingula (unguis), Bruguière.
		Obolidæ	Obolus (Apollinis), Eichwald.
		Craniadæ	Crania (Egnabergensis), Retzius.
			Siphonotreta (unguiculata), De Verneuil.
			Criopus (turbinatus), Poli.
		Discinidæ	*Discina* (ostreoides), Lamarck.
			Orbiculoidea, A. d'Orbigny.
			Trematis (terminalis), Sharpe.
		Calceolidæ	Calceola (sandalina), Lamarck.
		Davidsonidæ	Davidsonia (Verneuilia), Bouchard Chanteraux
		Productidæ	*Productus* (Martini), J. Sowerby.
			Strophalosia (excavata), King.
		Strophomenidæ	Strophomena (rugosa), Rafinesque.
			Leptæna (rugosa), Dalman.
			Chonetes (sarcinulata), Fischer.
			Orthis (pecten), Dalman.
			Schizophoria (resupinata), King.
			Streptorhynchus (pelargonatus), King.
			Orthisina (plana), A. d'Orbigny.
			Dicælosia (biloba), King.
			Platystrophia (biforata), King.
	Sclerobrachia.	Hypothyridæ	Isorhynchus (æquirostris), King.
			Hypothyris (cuboides), Phillips.
			Camarophoria (Schlotheimi), King.
			Uncites (Gryphus), Defrance.
			Pentamerus (Knightii), J. Sowerby.
		Spiriferidæ	Atrypa (reticularis), Dalman.
			Athyris (concentrica), M'Coy.
			Cleiothyris (pectinifera), Phillips.
			Retzia (Adrieni), King.
			Delthyris (elevata), Dalman.
			Trigonotreta (Stokesii), Kœnig.
			Spirifer (cuspidatus), J. Sowerby.
			Martinia (glabra), M'Coy.
ANCYLOPODA.	*Ancylobrachia*.	Strigocephalidæ	Strigocephalus (Burtini), Defrance.
		Terebratulidæ	*Epithyris* (elongata), Phillips.
			Terebratella (Chilensis), A. d'Orbigny.
			Terebratula (vitrea), Lamarck.
			Pygope (diphya), Link.
			Eudesia (orbicularis), King.
			Megerlia (truncata), King.
			Waldheimia (Australis), King.
		Rhynchoridæ	Ismenia (pectunculus), King.
			Delthyridæa, M'Coy.
			Rhynchora (costata), Dalman.
		Magasidæ	Magas (pumilus), Sowerby.
			Bouchardia (rosea), Davidson.
		Thecidæidæ	Thecidæa (Mediterranea), Defrance.
		Argiopidæ	Argiope (detruncata), Eudes-Deslongchamps.[2]

[1] The genera in italics are Permian.

[2] I demur to the order *Cryptobrachia*, proposed by Mr. J. E. Gray for *Thecidæa* and *Argiope*, until more is known respecting the molluscs belonging to these genera. From Professor E. Forbes's statements (which I had not seen when my previous remarks on Thecidæa were written), it would appear that *Argiope* is a

The subdivisions *Helictopoda* and *Ancyclopoda*, lately proposed by Mr. J. E. Gray, are respectively represented by Palliobranchs possessing *spirally-rolled*, and *recurvedly-folded* labial appendages.[1]

Sub-kingdom HELICTOPODA,[2] J. E. Gray.

Diagnosis.—"The oval arms are elongate, regularly spirally twisted when in repose."[3]

I have not transcribed the whole of the diagnosis given by Mr. J. E. Gray, as he was not aware, at the time of drawing it up, that the group, contrary to his views, comprised several genera, having the substance of the valves pierced with minute perforations.[4]

true brachiferous Palliobranch. "Although Philippi describes *Terebratula detruncata* (the type of Argiope) as having no arms, but only cirrhi attached to the apophyses, our own examination of that animal would rather go to maintain the existence of true but fixed arms; and in the curious Orthis anomoides of Scacchi and Philippi (which is the *Terebratula depressa* of the 'Report on the Mollusca of the Ægean), the latter eminent malacologist figures and describes two perfect spiral cirrigerous arms, &c."—British Mollusca, vol. ii, p. 360. The expression "spiral cirrigerous arms,"—whether does it imply organs such as the spirally-folded labial appendages of the Helictopods, or the recurvedly-folded homologues of the Ancylopods?

[1] 'On the Arrangement of the Brachiopoda,' by J. E. Gray, Esq., F.R.S., in the Annals and Magazine of Natural History, 2d series, vol. ii, pp. 435-9, 1848.

[2] I have reversed the order of Mr. Gray's arrangement, as I feel persuaded that all classifications of the Animal and Vegetable Kingdoms should be based on the two principles—*order of creation*, and *affinity*. I have elsewhere alluded to these principles (vide Annals and Magazine of Natural History, vol. xiv, pp. 271-9); and I regret that I am not yet prepared to draw up a classification of palliobranchiate shells, in accordance with them, or what may be termed the Chronogenic system. It may suffice for the present, however, my observing, that the Helictopods appear to have been the earliest created forms of the class. It is exceedingly difficult to say which genus was first created. Perhaps the most correct view is the one admitting a synchronous creation of several genera; for it is a remarkable fact, that out of thirty-four known helictopodous genera, about twenty-six have been found in the Silurian or earliest rocks. I have commenced with *Lingula*, because it is certainly one of a few of the earliest palliobranchiate genera known, having been found in the lowest of the Silurians, at Tremadoc, in North Wales, and at Kelsville (Potsdam Sandstone), in the United States. With regard to the Ancylopods, it is not so clear that any of them existed in the earliest organic periods; at least, I do not feel myself qualified to speak positively regarding any, with the exception of *Strigocephalus*, and this is a genus not yet known to occur in any rocks below the Devonian. The ever-prevailing paucity of the Ancylopods is strikingly contrasted with the almost constant profusion of the Helictopods. Neither division may be said to be abundant at the present time; but perhaps the Ancylopods were seldom (unless we except the Jurassic period) much more numerous than what they are at present.

[3] Op. cit., p. 437.

[4] The remainder of the diagnosis is as follows "The mantle-lobes are merely applied to the inner surface of the shell, and the substance of the valves is not pierced with minute perforations, though the surface is sometimes spinulose, the spines being only formed on the edge of the shell while it is being increased in size."

Order SARCICOBRACHIA, J. E. Gray.

Diagnosis.—"The oral arms fleshy, without any shelly support."[1]

Family LINGULIDÆ (Les Lingules), Cuvier, 1800.

The shells of this family are more or less elongated longitudinally, pointed at the beaks, sub-equivalve, regular, covered with an epidermis, and attached to marine bodies by a peduncle passing out between the beaks of the valves. The branchial system differs somewhat from that of other known Palliobranchs in consisting, though perhaps only partially, of slightly-developed tufts or processes originating from the great pallial vessels.

Genus *Lingula*, Bruguière.

Diagnosis.—"Testa subæquivalvis, planulata, ovato-oblonga, apice truncatâ, basi subacutâ, pediculo, carnosa tendineo, basi affixo elevata. Cardo edentulus."[2] (Lamarck.)

This is probably the most long-lived genus with which the palæontologist is acquainted. Its remains are found in the very earliest fossiliferous rock (vide note, p. 82); and it is still living at the present day; but what is most remarkable, it has never, during any period, been represented by more than a few species.

LINGULA CREDNERI, *Geinitz.* Plate VI, figs. 25, 26, 27.

	LINGULA MYTILOIDES, *J. Sowerby.*		(King) Bull. Soc. Géol. de Fr., 2me série, vol. i, p. 30, 1844.
—	—	„	Geol. Russ., vol. i, p. 222, 1845.
—	—	„	Tennant, Strat. List., p. 88, 1847.
—	—	„	King, Catalogue, p. 7, 1848.
—	—	(?) „	Howse, T. N. F. C., vol. i, p. 250, 1848.
—	CREDNERI, *Geinitz.*		Versteinerungen, p. 11, pl. iii, figs, 23, 24, 1848.

Diagnosis.—Shell thin; finely striated; oblong oval; rounded in front; with a median elevation (commencing at the posterior end, and becoming flattened anteriorly) from which the shell gradually slopes to the sides.[3]

[1] Gray, op. cit., p. 436.

[2] Animaux sans Vertèbres, t. vii, p. 386, 1836.

[3] "Die dünne, mit feinen Zuwachstreifen verzierte Schale ist länglich oval, untengerundet und lässt eine mittlere wulstförmige Erhebung erkennen, die an dem kleinen Wirbel beginnt und sich nach unten hin verflacht und von welcher die Schale nach beiden Seiten hin abfällt.—Bei 10 Millimeter länge, 6-7 Millemeter breit." (Geinitz, Versteinerungen, p. 11.)

I have now relinquished the idea of this shell being specifically identical with the *Lingula mytiloides* of the 'Mineral Conchology,' having examined two original specimens of the latter belonging to the cabinet of Mr. J. de C. Sowerby. One of these specimens, which is the original of the figures in the above work, has the margins of its posterior half broken; the shell is consequently more rounded posteriorly than it is represented. *Lingula mytiloides* is thus made to approach the form of *L. Credneri* more than the original figure; but after carefully restoring the posterior outline of Mr. Sowerby's specimens by continuing the lines of growth, I still found that it was more acuminated at the pedicle end than its Permian congener. *Lingula squamiformis*, Phill., appears to have a close resemblance to the Geinitzian species. None of my specimens display the posterior median ridge so developed as in those noticed by Dr. Geinitz: probably the more prominent form of this character in the German specimens is accidental—perhaps due to lateral pressure.

Lingula Credneri occurs abundantly, but generally in an imperfect condition, at Thrislington Gap, in the Marl-slate; and in the same deposit, though more sparingly, at Thickley, and Ferry Hill. Professor Johnstone informs me that he has procured specimens of a Lingula in the underlying Freestone (Rothe-todte-liegende) near Ferry Hill. Dr. Geinitz records its occurrence in the Zechstein of Corbusen, Cosma, and Ilmenau; also between Königsee and Unterschöblingen, in Thuringia.

Family Discinidæ, J. E. Gray.

Diagnosis.—"The upper valve is conical and patelloid, the lower orbicular; and is attached to marine bodies by a short tendinous pedicle, which passes out through a slit in the hinder part of the disc of the ventral valve."[1]

Genus *Discina*,[2] Lamarck, 1818.

Crania (*partim*), *Schumacher.*
Orbicula, *Auct.*

Diagnosis.—"Testa inæquivalvis, ovato-rotundata, depressiuscula; valvis magnitudine æqualibus, disco centrali orbiculato utrisque distinctis. Discus valvæ superioris

[1] Gray, op. cit., p. 439.

[2] Conchologists are much indebted to Mr. J. E. Gray for his rectifications of some prevailing errors respecting the genus *Discina* (vide 'Observations on the Synonymy of the genera Anomia, Crania, Orbicula, and Discina,' in the Annals of Philosophy, new series, vol. x, October 1825; and 'On the Arrangement of the Brachiopoda,' in the Annals and Mag. of Nat. Hist., 2d series, vol. ii, p. 439). The genus *Crania* was established by Retzius on the *Nummulus minor* of Stobæus (= *Crania Egnabergensis*, Retz., = *C. striata*, Lam.), between 1780 and 1790; Poli established the genus *Criopus* on (the animal of) his *Anomia turbinata* = *Crania ringens*, Hæningh., in 1793; Cuvier founded the genus *Orbicula* on a congeneric form,—the *Patella anomala* of Müller, in 1800; and Lamarck instituted, in 1818, the genus *Discina* on a shell, which

indivisus, medio submamillatus: alteræ valvæ candidissimus, rima transversa divisus."[1]

All the information that could be desired respecting the animal of this genus has been published by Professor Owen, in his admirable paper on the Brachiopoda, under the head of *Orbicula lamellosa*, Broderip.

Discinas existed in the earliest organic ages, and have lived throughout all subsequent periods up to the present time; but never to any extent as species. They now appear to be confined to the Pacific and Southern Oceans.

DISCINA SPELUNCARIA, *Schlotheim, apud Goldfuss.* Plate VI, figs. 28, 29.

ORBICULA SPELUNCARIA, *Schl.*			Handbuch der Geognosie, von H. T. de la Beche, p. 459, 1832.
—	—	„	Geol. Man., 3d Eng. ed., p. 573, 1833.
—	—	„	Phillips, Encyc. Metr., vol. iv, p. 615, 1834.
—	—	„	Bull. Soc. Géol. de France, 2^{me} série, vol. i, p. 30, 1844.
—	—	„	Geol. Russ., vol. i, p. 222, 1845.
—	KONINCKI, *Geinitz.*		Grundriss, p. 495, 1846.
—	SPELUNCARIA, *Schl.*		King, Catalogue, p. 7, 1848.
—	—	„	Howse, T. N. F. C., vol. i, p. 251, 1848.
—	KONINCKI, *Geinitz.*		Versteinerungen, p. 11, pl. iv, figs. 25, 26, 1848.

Diagnosis.—Form sub-orbicular. *Upper valve* moderately convex; with the umbone between its posterior margin and centre. *Inferior valve* flat; with the fissure extending from its centre to nearly the margin. *Both valves* marked with strong lines of growth.

The *specific name* herein adopted, having been applied by Schlotheim, according to Goldfuss, to a Discina found at Glücksbrunn, evidently identical with the species under consideration, I prefer retaining it to adopting the one which has been subsequently proposed by Dr. Geinitz; particularly as the former name was current for a considerable time previously to the publication of the 'Grundriss.'

The specimen under figure 28, Pl. VI, with two more, was found attached to the small valve of a *Productus horridus.*

he named *D. ostreoides* (? = *Orbicula lamellosa*, Broderip). Now, leaving out of view Cuvier's *Orbicula*, it having been anticipated by Poli's *Criopus* (and subsequently confounded, through an error, with Lamarck's *Discina* by most authors), I am disposed to recognise the three remaining genera; since the *Crania Egnabergensis* is attached only by a portion of its under valve (it appears to have been only thus attached when young); *Criopus turbinatus* is attached by the entire surface of the same valve; and *Discina ostreoides* is simply attached by a tendon or muscle passing out through a fissure in the under valve. By adopting the genera *Crania*, *Criopus*, and *Discina*, as above typified, we not only preserve one or two names which have been threatened with extinction; but we arrange under the first head certain shells, such as *C. spinulosa*, *C. nummulus*, *C. antiquissima*, which, from their imperfect mode of attachment, are obviously distinguished from such completely attached forms as *Criopus anomalus*, *C. turbinatus*, *C. Parisiensis*, &c. Perhaps some of the Cranidias above mentioned may hereafter be made typical of other genera.

[1] Animaux sans Vertèbres, t. vii, p. 296, 1836.

Discina speluncaria occurs at Thrislington Gap, in the Marl Slate; at Garmundsway (the locality of the above-noticed specimens), in the overlying beds of compact Limestone; and at Tunstall Hill, in the Shell-limestone. It was first noticed by Schlotheim at Glücksbrunn: it has also been found at Ilmenau and Corbusen, in the lower Zechstein (Geinitz).

Family Productidæ, J. E. Gray (*partim*), 1841.

This group of Palliobranchs is typified by the genus *Productus*, as constructed by Mr. James Sowerby. Mr. J. E. Gray, in the 'Catalogue of the British Museum,' 1841, included in it the genus *Calceola;* and of late the same author has made it to comprise "the genera *Productus*, Sow., *Strophalosia*, King, *Chonetes*, Fischer, *Leptæna* and *Orthis*, Dalman, *Strophomena*, Rafinesque, and *Calceola*, Lamarck."[1] Notwithstanding that the high authority just quoted differs from me, I still feel it necessary to limit the family to *Productus* and *Strophalosia*, as proposed in my former paper,[2] considering that these genera differ from all the others above named in their reniform impressions, which obviously constitute a capital family diagnosis.

Taking *Leptæna analoga* and *Productus horridus* as examples illustrating the characterism of the vascular system of their respective families, it may be predicated of *Strophomenidæ*, that the primary pallial vessels are more or less confined to the medio-longitudinal region of the valves; and of *Productidæ*, that they strike off at the moment they issue from between the muscular scars, in a lateral direction, running for some distance nearly parallel to the cardinal line, then curving forward, and round toward the centre, and finally returning to nearly their origin. Looking at the vein-like line bounding the reniform lobes of *Productus horridus* (Pl. XI, fig. 10*f*) and *P. semireticulatus* (Pl. XIX, fig. 3*f*), I cannot but think that these structures are each due to a recurving vessel, rather than to an expanded and simply projecting vascular organ, as appears to be the case in *Criopus*.

Genus *Productus*, J. Sowerby, 1814.

Gryphites, *Walch.*
Anomites, *Martin.*

Diagnosis.—"An equilateral unequal-valved bivalve, with a reflexed, more or less cylindrical margin. Hinge transverse, linear. Beak imperforate; one valve convex, the other flat or concave internally."[3] (J. Sowerby.)

Productus longispinus is the first species described and figured by Mr. J. Sowerby under the head of this genus; but from what is stated in the 'Mineral Conchology,'

[1] Annals and Mag. of Nat. Hist., 2d series, vol. ii, p. 438.
[2] Annals and Mag. of Nat. Hist., vol. xviii, p. 28, 1846.
[3] Mineral Conchology, vol. i, p. 153, 1814.

vol. i, p. 153, it is necessary to consider the *Conch. Anomites productus*, of Martin, as its type.

Although this remarkable genus possesses in its external (concavo-convex) form a striking resemblance to certain species of *Strophomena* and *Leptæna*, it is nevertheless easily distinguished from them by the want of teeth, and an area, and by the surface of its valves (the large one in general, and the small one occasionally) being furnished with spines. So far as is yet known, *Chonetes* is the only long-established genus likely to be confounded with *Productus*, on account of its being spiniferous; but in the former the spines are confined to the cardinal margin.

Late researches have proved the Silurian existence of this genus. Prof. M'Coy first described two species, *Productus moniliferus* and *P. tenuicinctatus*, in the Silurian rocks of Ireland;[1] Mr. Davidson next described a species, *P. Twamleyi*, discovered by Mr. Gray in the Dudley Limestone;[2] and at the same time M. de Verneuil published a full description of another species, *P.* (*Leptæna*) *enigma*, found in the "inferior Silurian Limestone of Osmundberg, in Dalecarlia."[3] The genus *Productus* may therefore be said to have commenced its existence in the earliest known organic age; and considering that no remains have yet been found in rocks more recent than the calcareous Marls of St. Kassian,[4] it may be said to have become extinct about the early part of the secondary period. Productuses do not appear to have existed to any extent until a considerable time after their first creation, since the greatest number of known species belong to the Carboniferous system.

PRODUCTUS HORRIDUS, *J. Sowerby*. Plate X, figs. 29, 30, 31; Pl. XI, figs. 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13.

VERSTEINERTER GRYPHIT, *Hoppe*, Kurze Beschreibung Verst. Gryph., &c., 1745.

GESPALTENE GRYPHITEN, *Knorr et Walch*. Naturg. der Verst., vol. ii, p. 79, pl. B, i *d*, figs. 5, 6; pl. D, figs. 1-3, 1768.

— — *Walch*. Das Steinreich, vol. i, p. 160, pl. xix, fig. 2, 2d edition, 1769.

GRYPHITEN VON GERA, *Schröter*. Journ. für die Leibh. des Steinr., vol. ii, p. 326, pl. i, fig. 5, 1775.

GESPALTEN GRYPHITEN, ,, Lithol. Real u. Verballexik, vol. ii, p. 309, 1779.

GERAISCHE GRYPHITEN, *Walch*. Der Naturforscher, vol. xiv, p. 24, 1780.

GRYPHIT MIT STACHELN, *Schlotheim*. Gesells. Naturf. Freunde zu Berlin, vol. iv, p. 75, pl. ii, fig. 1, 1810.

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[1] A Synopsis of the Silurian Fossils of Ireland, p. 25, 1846.

[2] Bulletin de la Société Géologique de France, t. v; séance du 5 Mai, 1848.

[3] Idem.

[4] Herrn von Klipstein notices three species occurring in the St. Kassian beds. (Vide Karsten und Dechen, Archiv für Min., Geog. &c., 1843, p. 352.) Dr. de Koninck only notices one species (*Productus Leonhardi*) in his 'Monographie du genre Productus.'

Gryphites aculeatus, *Schlotheim.* Taschenbuch, vol. vii, pp. 56, 58, pl. iv, figs. 1, 2 (fig. 3 exclusa), 1813.

Curious shell,[1] *Thomson.* Annals of Philosophy, vol. iv, p. 18, 1814.

A species of Cardium, *J. B. Taylor.* Surtees, Hist. Durham, vol. i, p. 236, 1816.

(?) Casts of Anomiæ, *Winch.* Trans. Geol. Soc. Lond., vol. iv, p. 10, 1817.

Gryphites aculeatus,[2] *Schl.* Petrefactenkunde, p. 293, 1820.

Productus horridus, *J. Sow.* Min. Conch., vol. iv, p. 17, pl. cccxix, fig. i, 1823.

— Hoppii, *Kœnig.* Icones Sect. Foss., pl. ix, fig. 108, 1825.

Gryphites aculeatus, *Schl.* Boué, Edin. Phil. Journ., vol. xii, p. 144, 1825.

Producta calva, *J. de C. Sow.* Min. Conch., vol. vi, p. 115, pl. dlx, figs. 2-6, 1827.

Productus aculeatus, *Schl.* Bronn, Zeitschrift, vol. ii, p. 543, 1827.

— horridus, *J. Sow.* Fleming, Brit. Animals, p. 379, 1828.

— aculeatus (Gryphites), *Schl.* Alex. Brongniart, Tab. de Ter., p. 423, 1829.

Producta antiquata, *J. Sow.* J. de C. Sow., Trans. Geol. Soc. Lond., 2d series, vol. iii, p. 119, 1829.

— calva, *J. de C. Sow.* Loc. cit.

— horrida, *J. Sow.* Loc. cit.

— aculeata, *Schl.* De la Beche, Geol. Man., p. 384, 1831; German transl., p. 459, 1832; and 3d Eng. ed., p. 573, 1833.

— antiquata, *J. de C. Sow.* Loc. cit.

— calva ,, Loc. cit.

Productus aculeatus, *Schl.* Kurtze, Petr. Mansf., p. 33, 1833.

Producta aculeata, ,, Phillips, Encyc. Met., vol. iv, pl. iii, fig. 1, p. 617, 1834.

— antiquata, *J. de C. Sow.* Loc. cit.

— calva ,, Loc. cit.

Strophomena aculeata, *Schl.* Bronn, Lethæa Geognostica, vol. i, p. 86, pl. iii, fig. 1 *a*, *b*, *c*, 1835.

Producta — ,, Quenstedt, Wiegmann's Archiv, vol. ii, p. 76, pl. i, fig. 2 *a*, *b*, *c*, 1835.

Productus tubuliferus, *Deshayes.* Lamarck, Anim. sans Vertèb., t. vii, p. 379, 2d ed., 1836.

— calvus, *J. de C. Sow.* Deshayes, op. cit., t. vii, p. 381, 1836.

Producta horrida, *J. Sow.* Phillips, Lardner's Cyclopædia, Geology, vol. i, p. 190, fig. 5, 1837.

— calva, *J. de C. Sow.* Lyell, Elements of Geology, p. 416, fig. 240, 1838.

Productus aculeatus, *Schl.* Von Buch, Akad. Berl., Theil i, p. 35 (excl. p. 27), pl. ii, figs. 13-15, 1840.

— — ,, Leonhard, Geologie, vol. iii, p. 26, pl. lxi, fig. 3, 1840.

— — ,, Geinitz, Jahrbuch, p. 640, 1841.

— calvus, *J. de C. Sow.* Morris, Catalogue, p. 126, 1843.

— aculeatus, *Schl.* Geinitz, Gæa von Sachsen, p. 97, 1843.

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[1] "This most curious shell has some resemblance to a shell observed by Martin in the Magnesian Limestone of Bredon in Derbyshire, and probably constituting a species of the same genus." (Thomson, loc. cit.)

[2] Schlotheim's specific name *aculeatus* is now abandoned for the shell under consideration, as Martin, in his 'Petrefacta Derbiensa,' 1809, had previously applied the same name to another *Productus* found in the Mountain limestone.

PRODUCTUS HORRIDUS, *J. Sow.* Brown, Fossil Conchology, pl. lvi, figs. 13, 14, 1843 (?).
— — „ De Verneuil, Bull. Soc. Géol. de France, 2me série, t. i, p. 29, 1844.
— — „ Desor, Min. Conch. de Sowerby, p. 352, pl. ccxi, cccxix, figs. 1, 2, 1845.
— CALVUS, *J. de C. Sow.* Desor, op. cit., p. 577, pl. ccclx, ccclxv, figs. 3-5, 1845.
— HORRIDUS, *J. Sow.* Geol. Russia, vol. i, p. 222, 1845.
STROPHOMENA ACULEATA, *Schl.* Schmidt, Petrefacten-Buch, p. 25, pl. iv, fig. 6 *a*, *b*, 1846.
PRODUCTUS HORRIDUS, *J. Sow.* Geinitz, Grundriss, p. 521, pl. 21, fig. 17 *a*, *b*; pl. xxii, fig. 8, 1846.
— — „ Tennant, Strat. List Brit. Fossils, p. 88, 1847.
— — „ De Koninck, Mém. Soc. Roy. Liége, t. iv, pp. 266-72, pl. xv, fig. 1 *a*, *b*, *c*, *d*, 1847.
— — „ King, Catalogue, p. 8, 1848.
— — „ Howse, T. N. F. C., vol. i, p. 256, 1848.
— „ Geinitz, Versteinerungen, p. 15, pl. vi, figs. 1-14, 1848.

Diagnosis.—" Quadrangular, with a large furrow along the middle, eared, thorny. Ears prominent, sub-cylindrical. Beak incurved, large."[1] (J. Sowerby.)

The researches of Dr. de Koninck (whose synonymy for the last century I have fully availed myself of) into the bibliographical history of this species, have shown that it is the most anciently-recorded Productus known, having been first noticed by Hoppe so early as 1745.

Productus horridus is found under so many forms, that any one might, at first, be tempted to divide it into a number of specific groups; but I am fully convinced that a more intimate acquaintance with all the various appearances and conditions under which the species occurs, cannot but lead to the conclusion that it is not so far divisible. In Plates X and XI will be found some of the principal varieties, which, it requires to be remarked, are characteristic of certain localities: thus the Whitley specimens (Pl. XI, fig. 1) are narrower and comparatively higher than those found at Humbleton (Pl. XI, fig. 4) and Derbyshire, and they possess a shallower median furrow; while the Garmundsway (Pl. X, figs. 29, 30, 31) and Thickley specimens are intermediate in these respects; besides, the Humbleton and Derbyshire varieties have not the square form possessed by the latter. The former are also more decidedly ridged in the longitudinal sense (compare fig. 23, Pl. X, with fig. 3, Pl. XI). Similar varieties occur in Germany. I procured at Kamsdorf a specimen equally as wide as any found at Humbleton; whereas all the Glücksbrunn specimens I have seen are narrow, like those occurring at Garmundsway. There also appears to prevail a difference in the form of the boss or cardinal muscular fulcrum, which is trilobed, with the lobes convex, in the Garmundsway examples (Pl. XI, fig. 12); but bilobed, with the

[1] Mineral Conchology, vol. iv, p. 17, 1823. It affords me much pleasure to state that Mr. J. de C. Sowerby has kindly lent me for illustration (vide Pl. XI, figs. 2, 3) two beautiful specimens of this shell, one of which served as the original or type of the species. (Vide Min. Conch., vol. iv, p. 17, pl. cccxix, fig. 1.)

lobes concave, in those found at Humbleton (Pl. XI, fig. 11). I do not insist on this being a positive difference, because there is some appearance of its being due to dissimilar modes of fossilization.

This species is remarkable for its small valve possessing two sets of spines, as exhibited on the casts from Humbleton, represented by figs. 6, 7, Pl. XI. One set consists of one or more rows of perfect spines confined to each lateral half of the cardinal region, and slightly divaricating radiately from the hinge-line as they strike off from its centre: they are hollow, and have evidently had a permanent communication with the inner surface of the valve. The Derbyshire specimen, represented by fig. 2, Pl. XI, beautifully exhibits these spines; and I have seen them nearly as prominently displayed in a specimen collected at Garmundsway. The other set consists of abortive spines, that is, they have never been developed to the extent of the latter; nor do they communicate with the inner surface of the valve, at least when the shell is in an advanced stage of growth: it is necessary to make this reservation, as I have seen young specimens (Pl. XI, fig. 9), in which these spines were very distinct, and hollow like the others. The abortive spines have a somewhat regular radiate arrangement. The spines of the opposite valve appear to have always communicated with its inner surface: they occasionally display a tendency to follow the same arrangement as those on the small valve; and exhibit no other difference among themselves than being more crowded in the cardinal rows. The fossils represented by figures 2, 5, Pl. XI, will afford a tolerably good idea of the size and other peculiarities of the cardinal spines of both valves. It is very seldom that a specimen is found with these appendages preserved; but occasionally the investing matrix shows them attached to the surface of the large valve; when their direction and length may be pretty accurately determined. I have seen a spine thus attached, apparently complete, measuring full two inches in length.

The Humbleton Hill specimens of this shell generally occur in the state of casts, which, although on this account are deficient as regard external characters, so finely displayed in some of the Derbyshire specimens, are, nevertheless, highly instructive as respect the internal structures. Having availed myself pretty freely of gutta percha (so indispensable to a palæontologist) in the way of taking impressions of these casts, I have been enabled to reproduce, as it were, the entire inner surface of a number of small valves, with all their respective structures as perfectly displayed as when the shells to which they belong were inhabited by their living occupants. One of these gutta-percha casts is represented by figure 10, in Plate XI: all the structures thereon displayed are more or less seen on impressions I have taken from a number of specimens; but in this one their combination and sharpness are better exhibited than in any of the others. In noticing these structures, attention must be directed, in the first place, to the boss or *cardinal muscular fulcrum* (*a*), which has precisely the same bilobed form already noticed, as occurring in the specimen represented by fig. 11, Pl. XI:

from its projecting so far behind the hinge-margin ; and from the vertical position of the face on which the muscle it supported has been implanted, it would appear that the opposite end of this (cardinal) muscle has not been attached to any part of the umbonal cavity, in front of a transverse line drawn exactly vertical to the structure in question. Nothing can be more satisfactorily clear than the origin of the *reniform impressions* (*f*), as indicated in the figure,—an origin which, when considered in connexion with what is displayed in the fossils represented elsewhere (vide Pl. XIX, fig. 3*f*; Pl. XX, fig. 7*f*), may now be considered as established beyond a doubt. What are called the *anterior divisions of the valvular muscular impressions* (*d*), are also finely displayed on the gutta-percha casts ; but it is to be regretted, owing to the small size of the figure, that certain characters which distinguish them from the *posterior divisions* (*c*), cannot be so faithfully represented as in the original : they are more elevated than the latter, and less complexly dendritic. The *dotted impressions* (*e*) are not often visible ; but having seen the same on various casts, I feel little doubt of their being due to the attachment of some muscles,—the inferior pedicle muscles very probably. The *spine-like tubercles* crowding the inner surface of the valve, are often very finely preserved : they have evidently increased with age, as I have seen large specimens in which those situated in front were nearly thrice the size of their analogues on the specimen figured.

The structure of the shell of *Productus horridus* is represented in fig. 13, Pl. XI : at *a* a magnified view is given of the thin superficial lamina, with its striæ of growth ; and at *b* the substance of the valve (the large one), which consists of closely-packed fibres (? capillary tubuli), running nearly parallel to the outer layer.

Hitherto no one has identified this species with any forms occurring in other formations than the Permian ; but I am strongly disposed to think that, before long, its chrono-geological range will be found to be more extended. I am inclined to this view, from having seen a specimen in the London Geological Society's Collection, labelled "*Producta Leuchtenbergiana*, from Lough Macnean, Fermanagh," bearing a striking resemblance to this species. It is only an examination of a number of specimens of the latter shell that would enable me to pronounce a positive opinion as to its specific identity with the Permian species.

Productus horridus is a widely-distributed fossil. As British, it was first described (1823) by Mr. J. Sowerby, who states it to be "from the seventh bed of Mr. White Watson's first Limestone, probably Magnesian, as it is above the coal series" in Derbyshire, "where it is not very rare." (Min. Conch., vol. iv, p. 17.) It also occurs very abundantly in the Shell-limestone at Humbleton Quarry ; not quite as much so, in the corresponding rock, at Tunstall Hill and Dalton-le-Dale. A few specimens occurred to me in the Breccia at Tynemouth Cliff : it is also found in the compact Limestone at Midderidge, Garmundsway, Millfield Quarry (Sunderland), and Whitley. Professor Sedgwick, who notices most of the foregoing localities, also states it to occur

abundantly in the dark bluish Limestone near Nosterfield (Geol. Soc., 2d series, vol. iii, pp. 108, 119). As German, it is a widely-distributed and well-known species, being found at Katterfeld, Schmerbach, Ilmenau, and Thalliter in the Kupferschiefer; and at Grafenheim, Könitz, Seissla, Kamsdorf, Röpsen, Glücksbrunn, Wöhlsdorf, Gera, Ronneburg, and some other localities in the lower beds of the Zechstein.

PRODUCTUS UMBONILLATUS, *King*. Plate XI, figs. 14, 15, 16, 17, 18.

PRODUCTUS UMBONILLATUS, *King*. Catalogue, p. 8, 1848.
— LATIROSTRATUS, *Howse*. T. N. F. C., vol. i, pp. 256, 257, 1848.

Diagnosis.—Form subtriangular marginally; plano-convex medio-longitudinally. *Large valve* slightly convex; scantily spinous; with a shallow median furrow; and a small, pointed, more or less projecting umbone, which is flattened on the side adjoining the hinge. *Small valve* nearly flat; with a prominent boss or cardinal muscular fulcrum.

I am not certain but this singular species will eventually be found to belong to another genus, perhaps the *Aulosteges* of Helmerson, supposing it to be really distinct from *Strophalosia*. The flattened space on that side of the umbone adjoining the hinge has somewhat the appearance of an area (see the inferior side of the prolongation [umbone], on the right side of fig. 18, Pl. XI); but I cannot convince myself that the part referred to is a true example of this structure: it also possesses something like a closed fissure, which, however, I suspect is simply a notch in the flattened (or area-like) space, caused by the cardinal boss pressing against it. I can say with safety, that it is not furnished with any teeth; it consequently cannot be a *Strophalosia*.

I have long considered this species to be distinct from *Productus horridus*, having, in 1843, sent specimens under its present name (which was inserted in my MS. Catalogue forwarded at the same time) to my valued friend M. de Verneuil. *Productus umbonillatus* differs from the latter species in its subtriangular form; in the want of ears; in being considerably less convex; and in having a small pointed beak, without any incurvation.

It is of rare occurrence in the Shelly Limestone at Tunstall Hill and Dalton-le-Dale. As yet it does not appear to have been found in Germany, unless a fossil figured by Geinitz (Versteinerungen, pl. vi, fig. 3) from Corbusen should prove to be the same species.

Genus *Strophalosia*, King, 1844.

Spondylus (Goldfussi), *Münster*, 1839.
Orthis (excavata), *Geinitz*, 1842.
Strophalosia (= Leptænalosia), *King*,[1] 1844.
Productus, *de Verneuil*, 1845.
(?) Aulosteges, *Helmerson*, 1847.
Orthothrix *Geinitz*, 1848.

Diagnosis.—A Productidia having the large valve (occasionally the small one) furnished with an area divided by a deltidium; and both valves articulating by means of teeth and sockets,—the former situated on each side of the base of the deltidium of the large valve, and the latter on each side of the *boss* or cardinal muscular fulcrum of the small valve.

Type, *Orthis excavata*, Geinitz=*Strophalosia spinifera*, King.[2]

In a paper published in the 'Annals and Magazine of Natural History,' for November 1844, I announced my intention of instituting the present genus "for a Productus-like shell with an area, and possessing a condyloid (condyliferous) hinge, as in Terebratulæ, and not a simple one, as in the true Producti:" and in my paper on the 'Palliobranchiata,' subsequently published in the same journal, I entered into some details on this group, showing its distinctiveness, and how it differed from *Productus*, a closely-allied generic form. Since the last paper appeared, Colonel von Helmerson[3] has proposed the genus *Aulosteges* for a singular shell (named by himself *A. variabilis*) occurring rather abundantly in the Permian limestones of Mount Grebeni in the North of Orenbourg, Russia, and which is now known to be identical with M. de Verneuil's *Orthis Wangenheimi*. Colonel Helmerson considers this genus to be distinct from my *Strophalosia*; but I regret that its principal distinctive features are not so clearly shown as could be desired. The presence of spines on the deltidium[4] constitute, in my opinion, the only distinctive character; but I am not prepared positively to deny the existence of deltidial spines in *Strophalosia*, though, with the exception of some obscure indications (in the form of irregular risings on the deltidium) in *S. Goldfussi*, they do not appear to be characteristic of the species herein described.

[1] The name *Leptænalosia*, a mere provisional MS. name noticed in the 1st vol. of the Geology of Russia, was shortly abandoned for the one now adopted.

[2] Vide Annals and Magazine of Natural History, vol. xviii, p. 28.

[3] "*Aulosteges variabilis*, ein neuer Brachiopode mit articulirtem Schlosse, aus dem Zechstein Russlands," von G. Von Helmerson; Lu le 22 Janvier 1847: and published in the Bulletin de la Classe Physico-Mathématique de l'Académie des Sciences de St. Petersbourg, t. vi, No. 9.

[4] Mr. T. Davidson assures me, that both he and M. de Verneuil, from an examination of specimens in the latter gentleman's collection, are convinced that spines do exist on the deltidium of *Aulosteges variabilis* = *Orthis Wangenheimi*, a character of which I have hitherto entertained some doubt.

Perhaps the development of deltidial spines may only be a feature in those Strophalosias with a large area, like that of *Aulosteges Wangenheimi*. *Strophalosia Goldfussi* has a large area; and its deltidium, as already noticed, possesses obscure indications of irregular risings: perhaps the latter are rudimentary deltidial spines? It will thus be seen, if *Aulosteges* possess no other distinctive character than the one just noticed, tha I am little disposed to regard it as distinct from *Strophalosia*.

With respect to Dr. Geinitz's genus *Orthothrix*, it is obviously the same as *Strophalosia*, the name of which claims adoption on account of its having nearly two years priority of publication.

Dr. de Koninck, in his 'Monographie du Genre Productus,' objects to the genus *Strophalosia* on some very insufficient grounds;[1] but it is singular that this gentleman, in describing his *Productus Buchianus*, overlooked the area and teeth, which I readily discovered on some specimens in the collection of Mr. T. Davidson. There is no doubt on my mind of this shell being a true *Strophalosia*, a view completely proved by the form of its reniform impressions.

I may here advert to the interesting shell figured by Mr. J. de C. Sowerby in the 'Mineral Conchology,' pl. 615, fig. 16 *b b*, under the name of *Leptæna anomala*. Mr. Sowerby having very kindly permitted me to make an examination of the original of these figures, I have been able to satisfy myself that it does not belong to *Leptæna*, at least, limited as this genus must be, to forms represented by its type, the *L. rugosa* of Dalman. Although I closely examined the specimen, I regret, from not being able to observe any teeth, my inability to speak with certainty as to the genus in which it ought to be placed. In its area and deltidium this shell corresponds with the genus under consideration; but until something is known of its internal characters, I feel reluctant to make any more than this passing allusion to the agreement.

I was formerly somewhat of the opinion that *Strophalosia* differed from *Productus* in having both valves furnished with spines;[2] but their occurrence on the same valve of *Productus horridus* (vide ante, p. 90), *P. punctatus*,[3] and some others,[4] shows that I was premature in this respect.

Perhaps what has just been noticed ought to induce some caution in repeating what I formerly stated respecting there being "a slight but interesting difference between

[1] If the so-called *Productus punctatus*, with an area and a fissure, figured by Dr. de Koninck (Mon., pl. xiii, fig. 2 *b*), as showing the futility of any genus founded on these characters, is really of the species named, the argument amounts to nothing, as it is founded on merely an abnormal form.

[2] Vide Annals and Magazine of Natural History, vol. xviii, p. 28.

[3] M. de Verneuil notices the presence of points (petites piqures) on the flat valve of this species when slightly deprived of a portion of its shell (vide Geol. Rus., vol. ii, p. 777). I have a specimen exhibiting the same valve furnished with spines as long and as crowded as they are on the large valve represented in the work quoted, at figure 3, plate xviii.

[4] *Productus spinulosus* (vide Min. Conch., pl. lxviii, fig. 3) is stated to have its small valve furnished with spines.

Strophalosia and *Productus* in their ovarian impressions or crescent-shaped bodies;"[1] though nothing has yet occurred to me appearing to militate against this conclusion. By referring to Pl. XII, figs. 2, 5, 9, 14, and 30, it will be seen, that in *Strophalosia* the vein-like line forming the reniform impressions (*e*, fig. 5, Pl. XII) does not return to nearly the muscular scars, as in *Productus* (vide Pl. XI, fig. 10 *f*), but to the anterior part of the median plate. Further, there is in the former a vein-like line (*f*, fig. 5, Pl. XII), connecting the reniform impressions with the medio-cardinal region of the shell, and which I have hitherto failed in discovering in any true Productus. I do not place much importance on the latter character; but I am certainly disposed to regard the former one as constituting a part of the generic diagnosis of *Strophalosia*. A further acquaintance with the internal structure of a number of species, however, is necessary before coming to any positive conclusion on this point.

I have represented a specimen of *Strophalosia parva*, which has evidently adhered, in the living state, to the inside of a *Productus horridus*, by means of its umbone (*a*, fig. 33, Pl. XII), and numerous long creeping spines belonging to the same part, as is the case with some genera of the present day, especially *Spondylus*. I have now seen so many specimens in this state—that is, with the umbonal spines following the exact concave curvature of the inside of the valve to which they adhered, and with the umbone always impressed, that no doubt remains on my mind of this being their mode of attachment: and from observing in all the Strophalosias with which I am acquainted, the umbone, more or less pressed in and distorted, I am led to believe, that this mode of attachment prevailed, at least in the young state, pretty generally throughout the genus.[2]

The data suggestive of this conclusion are of importance in another point of view, as they go far to disprove the view advanced by Dr. de Koninck, that *Productus* was attached by means of fibres, or a byssus passing out from between the anterior gape of the valves: no evidences are advanced in support of this view; and in their absence I am certainly more disposed to conclude from what has just been observed that these shells rested on their large valve, as is the case with *Pecten Jacobeus;* and were either free (as perhaps was the habit of *Productus giganteus*), or firmly moored by means of the cardinal spines to foreign bodies, as may be surmised of *Productus horridus*.

The present genus does not appear to have been in existence during any portion of the Silurian period; but the occurrence of such species as *Strophalosia* (*Orthis*) *productoides*, Murchison, and *S.* (*Productus*) *subaculeatus*, Murch., prove it to have formed a portion of the fauna characteristic of the Devonian system; while *S.* (*Productus*)

[1] Vide Annals and Magazine of Natural History, vol. xviii, p. 93.

[2] M. de Verneuil arrived at the same conclusion with the *Strophalosia* (*Productus*) *horrescens*, which is also furnished with a blunted umbone. (Vide Geol. Russ., vol. ii, pp. 280-1.)

Buchiana, de Koninck, a carboniferous species, and the four forms hereafter noticed, as well as some others described by M. de Verneuil, as occurring in Russia, show that it was continued up to the Permian period. It is to be regretted, with regard to *Strophalosia Gerardi* (which is represented in Pl. XIX, figs. 6, 7), that nothing certain is known as to its geological position. Dr. Gerard, who collected the specimen figured with others ("marine shells, resembling oysters") in crossing the boundary of Ladâkh and Bis-áhár in the Himalayas,[1] was unfortunately not sufficiently acquainted with fossils or geology to publish anything satisfactory on this point. Apparently the species belong to a deposit pertaining to the upper division of the primary system.

STROPHALOSIA GOLDFUSSI, *Münster*. Plate XII, figs. 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12.

(?) GRYPHITES RUGOSUS, *Schl.* Schlotheim, Taschenbuch, p. 58, 1813.
(?) CHAMITES GRANULATUS „ Boué, Edin. Phil. Journ., vol. xii, p. 144, 1825.
(?) PRODUCTUS RUGOSUS „ Brongniart, Tab. de Ter., p. 423, 1829.
(?) PRODUCTA RUGOSA „ De la Beche, Geol. Man., p. 384, 1831; Germ. Transl., p. 459, 1832; 3d Eng. ed., p. 573, 1833.
(?) — — „ Phillips, Encyc. Met., Geology, vol. vi, p. 617, 1834.
SPONDYLUS GOLDFUSSI, *Münster*. Beitrage, vol. i, p. 43, pl. iv, fig. 3 *a b*, 1839; Idem, Zweite Auflage, p. 65. pl. iv, fig. 3 *a b*, 1843.
— — „ Geinitz, Gæa von Sachsen, p. 96, 1843.
— — „ De Verneuil, Bull. de la Soc. Géol. de France, 2me série, t. i, p. 34, 1844.

[1] "The geological structure of the Spiti district commands a high degree of interest, from its numerous fossil remains, and the irregular character and magnitude of the scenes which represent them—the mountains, in many places, appearing to be formed entirely of shells and their exuviæ. Specimens of these fossils have been sent by me to Calcutta, where, no doubt, they will have been duly appreciated and elucidated by those who are more conversant than myself with the subject of fossil conchology. Some of the fragments were broken from masses of rock, lying at the foot of a cliff, from which they appeared to be detached, at a height of 15,000 feet. The cliff rose like a wall abruptly from the river, but its eastern side sloped off from a crest, 16,000 feet high, where some Ammonites were found. [One of the specimens now in my collection resembles *Ammonites elegans*.—W. K.] Illness, and the languor produced by such an attenuated atmosphere, prevented my taking every advantage of my visit to this interesting region, and my journey was terminated by the limits of the British territory. Just before crossing the boundary of Ladâkh and Bis-áhár, I was gratified by the discovery of a bed of marine shells, resembling oysters, and clinging to a rock in a similar manner; but the suspicions of the Chinese prevented my bringing away many specimens. The loftiest position at which I actually picked up some of the shells was on the crest of a pass, elevated 17,000 feet, where also were seen numerous blocks of calcareous silicious matrix. I was not able to pass more than a single day at this interesting spot; but I brought away numerous fragments of the rock." (Dr. Gerard, 'Asiatic Researches of the Bengal Society,' vol. xviii.)

Spondylus Goldfussi, *Münster*. Geol. Russ., vol. i, p. 224, 1845.
(?) Productus horridus, jun., *J. Sow*. Geinitz, Grundriss, p. 521, pl. xxii, figs. 9, 10, 1846.
Strophalosia.[1] King, An. and Mag. Nat. Hist., vol. xviii, p. 93, 1848.
Productus Goldfussi, *Münster*. De Koninck, Monog. Productus, p. 257, pl. xi, fig. 4, *a*, *b*, *c*, *d*, *e*; and pl. xv, fig. 4, *a*, *b*, 1847.
Strophalosia — ,, King, Catalogue, p. 9, 1848.
Productus Morrisianus, *King*. Howse, Trans. T. N. F. C., vol. i, p. 257, 1848.
Orthothrix Goldfussi, *Münster*. Geinitz, Versteinerungen, p. 14, pl. v, figs. 27, 28, 32, 33 *a*, *b*, *c* (excluding figs. 29, 30, 31, 34), 1848.

Diagnosis.—Form sub-triangular marginally. *Large valve* flatly convex; with (occasionally) a shallow median furrow, and numerous long, slender, curving spines: *area* somewhat narrow, and more or less elevated; with a narrow deltidium: *umbone* pointed, projecting behind the hinge, often blunted, and more or less irregularly twisted. *Small valve* slightly concave; with numerous declined rather long spines, and a small area.[2]

Strophalosia Goldfussi is an extremely variable species, rarely two species being found alike. The examples occurring at Ryhope Field-House Farm, differ from those to be found at Humbleton Hill in having the large valve more rounded, and with a very slight indication (in some specimens none) of a median furrow; their area, also, is not so high: in these respects they offer a close agreement with some of the German specimens figured in the 'Versteinerungen.' The singular projecting umbone (Pl. XI, fig. 1), and elevated area (Pl. XII, fig. 12 *a*) are features which give this species a very different aspect to what any of its known congeners possess, with the exception perhaps of the so-called *Orthis Wangenheimi*, de Vern. (= *Aulosteges variabilis*, Helm.), supposing it to be a species of *Strophalosia*.

The error committed by Count Münster in naming this fossil a *Spondylus* is a very pardonable one, considering the striking similarity it possesses, though on a small scale, with some species of this genus: its twisted projecting umbone, the inequality, spiny character, and form of its valves are interesting instances of the similarity; and, doubtless, the mode of attachment of both shells, that is, by their large valve or its umbonal region, forms another striking point of resemblance.

The fossil noticed by Schlotheim in the 'Taschenbuch' for 1813, p. 58, as occurring at Könitz, and which he identified with the *Gryphites rugosus*, is, I strongly suspect, the species under consideration, as it occurred to me very abundantly in this locality.

[1] One of the noticed "three Magnesian limestone species found in the neighbourhood of Sunderland." (Loc. cit.)

[2] The following is the original description of this species, published by Count Münster: "Die untere tiefe Schale ist mit feinen, langen, gebogenen, über und durch einander liegenden Stacheln dicht besetzt; auf der obern, flachen, etwas eingedrückten Schale sind die Stacheln kurz, in der Mitte wie erhabene Punkte am Rande etwas länger. Der Anheftungspunkt der Muschel war an der Schloss-seite. Wenn sie frei gewesen wäre, würde ich sie für einen Productus gehalten haben." (Beiträge, p. 65.)

Strophalosia Goldfussi is very common in the shell-limestone at Ryhope Field-House Farm, where a bed is filled with its casts. It is also found, but considerably less abundantly, in the corresponding rock at Humbleton Hill, Castle-Eden Dene, and Dalton-le-Dale: I succeeded in finding a few specimens in the Breccia of Tynemouth Cliff. It is a common fossil at Könitz, in Germany: Geinitz notices its occurrence also at Milbitz, Röpsen, and Corbusen, in the Lower Zechstein.

STROPHALOSIA EXCAVATA, *Geinitz*. Plate XII, figs. 13, 14, 15, 16, 17.

(?) GRYPHITES ACULEATUS, Jun., *Schl.* Leonhard's Taschenbuch, vol. vii, pl. iv, fig. 3, 1813.
ORTHIS EXCAVATA, *Geinitz*. Neues Jahrbuch, p. 578, pl. x, figs. 12, 13, 1842.
— — „ Gæa von Sachsen, p. 97, 1843.
— — „ De Verneuil, Bull. Géol. Soc. de France, 2me série, vol. i, p. 29, 1844.
STROPHALOSIA SPINIFERA, *King*. Op. cit., p. 30.
ORTHIS EXCAVATA, *Geinitz*. Geol. Russ., vol. i, p. 223, 1845.
STROPHALOSIA SPINIFERA, *King*. Loc. cit.
— — „ King, Annals and Mag. Nat. Hist., vol. xviii, p. 28, 1847.
PRODUCTUS LEWISIANUS, *Koninck*. Mon. du Genre Productus, p. 262, pl. xv, fig. 5 *a*, *b*, *c*, *d*, *e*, 1847.
— GEINITZIANUS, *Koninck*. Op. cit., p. 264, pl. xv, fig. 3 *a*, *b*, *c*, *d*, 1847.
STROPHALOSIA SPINIFERA, *King*. Catalogue, p. 9, 1848.
PRODUCTUS MORRISIANUS, *King*. Howse, Trans. T. N. F. C., vol. i, p. 257, 1848.
ORTHOTHRIX EXCAVATUS, *Geinitz*. Versteinerungen, pp. 14, 15, pl. v, figs. 35, 37; pl. vi, fig. 20 *a*, *b*, *c*, 1848.
— GOLDFUSSI, *Münster*. Op. cit., pl. v, fig. 30, &c.

Diagnosis.—"*Large valve* hemispherical oval (quer-oval), finally concentrically striated, and covered with long slender spines; with a small, low, rounded, pointed umbone: *area* high, and divided by a small occasionally slightly-indented deltidium (sinus). *Small valve* (in old examples) deeply concave, pouch-shaped, generally a little wider than long (its greatest width being about the middle of its length), and covered with small spines, as in the other valve. The *hinge* is about equal to two thirds of the widest part of the shell. The *area* is low."[1]

The typical *Strophalosia*.

I am induced to add the description of the shell given in my 'Catalogue,' as it notices one or two points overlooked by Dr. Geinitz. "*Form* roundish. *Area* narrow and slightly elevated. *Dorsal valve* roundly convex, with very long curved spines often

[1] "*Rückenschale* halbkugelig quer-oval, mit einem kleinen niedergebogenen spitzen Wirbel, einer hohen Area und einem schmalen, bisweilen nur schwach angedeuteten *Sinus*, fein concentrisch gestreift und mit dünnen, aber langen Stachelröhren besetzt. *Bauchschale* an ältern Individuen stark vertieft, taschenförmig, indem ihre grösste Breite unterhalb der Mitte der Länge liegt, meist etwas breiter als lang und mit ähnlichen Röhrenstacheln oder Warzen bedeckt, wie die andere Schale. Der Schlossrand nimmt ungefähr zwei Dritttheile der grössten Schalenbreite ein. Die Area der Ventralschale ist niedrig." (Geinitz, Versteinerungen, p. 15.)

somewhat arranged in lines, radiating and curving outwardly from the nucleus. *Ventral valve* concave, with very many declined longish spines having the same arrangement as those on the dorsal valve; umbone small, rounded, somewhat incurved, and slightly impressed."[1]

Strophalosia excavata differs from *S. Goldfussi* in the roundness of its marginal outline, the regular and strong convexity of its large valve, the rounded form of its umbone, the curvedly radiating arrangement of its spines, and the smaller size of its area. The arrangement of the spines constitute a capital distinctive character for this species, compared with its associates; and I regret that none of my figures represent it so clearly as could be wished: some of the figures in the 'Versteinerungen' (vide pl. v, fig. 30; pl. vi, fig. 20 *a*) have an advantage over mine in this respect. My description characterises the large valve as having the "*area* small and slightly elevated." This must be taken in comparison with the area of *Strophalosia Goldfussi*.

In my 'Catalogue' this species is named *Strophalosia spinifera;* but it is there suggested to be the *Orthis excavata* of Geinitz,—a suggestion confirmed by the publication of the 'Versteinerungen.' It requires to be mentioned, however, that I entertain a suspicion of some of the shells figured in this work, under the latter specific name, belonging to *Strophalosia Goldfussi*, and particularly the one originally given by Dr. Geinitz in the 'Neues Jahrbuch' (1842, pl. x, figs. 12, 13); but as certain of the specimens represented in the 'Versteinerungen' (pl. v, figs. 30, 37; pl. vi, fig. 20) are undoubtedly the same as my *S. spinifera*, and as my learned co-operator has identified his *Orthis excavata* with Dr. de Koninck's *Productus Lewisianus* and *P. Geinitzianus*, in which I entirely agree with him, I readily cancel my name and replace it by the one herein adopted.

Strophalosia excavata is found at Humbleton, Dalton-le-Dale, Tunstall Hill, Hylton North-Farm, and Tynemouth. Dr. Geinitz records its occurrence at Pössneck, Könitz, Liebenstein, and Hirschberg in the Zechstein. Should the so-called *Gryphites aculeatus*, jun., figured by Schlotheim in the 'Taschenbuch, (vol. vii, pl. iv, fig. 3, 1813) be the same, it may also be said to occur in the Kupferschiefer of Schmerbach.

STROPHALOSIA MORRISIANA,[2] *King*. Pl. XII, figs. 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32.

(?) GRYPHYTES ACULEATUS, Jun., *Schl.* Akad. Münch., vol. vi, p. 29, pl. viii, fig. 15 *a*, *b*, fig. 16 *a*, *b*, 1820.

(?) PRODUCTA—"perhaps a new species," *Phillips*. Philosophical Mag., N. S., vol. iv, p. 401, 1828.

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[1] King, 'Catalogue,' p. 9.

[2] In naming this shell after the author of the 'Catalogue of British Fossils,' I evince my respect for one who has frequently assisted me in my labours, and to whom, in a great measure, is due the publication of this Monograph by the Palæontographical Society.

(?) Producta spinosa, *J. Sow.* J. de C. Sowerby, Sedgwick, Trans. Geol. Soc., 2d series, vol. iii, p. 119, 1829.

(?) Producta longispina, *Sow.* De la Beche, Geol. Man., p. 384, 1831; Germ. Transl., p. 459, 1832; 3d Eng. Ed., p. 573, 1833.

Strophalosia Morrisiana, *King.* De Verneuil, Bull. de la Soc. Géol. de France, 2me série, vol. i, p. 30, 1844.

— — „ Geol. Russ., vol. i, p. 222, 1845.

— — „ King, Annals and Mag. Nat. Hist., vol. xviii, p. 28, 1847.

— — „ King, Catalogue, p. 9, 1848.

Productus spiniferus, *King.* Howse, Trans. T. N. F. C., vol. i, p. 257, 1848.

(?) Orthothrix lamellosus, *Geinitz.* Versteinerungen, p. 14, pl. v, fig. 16, &c., 1848.

Productus cancrini, *De Verneuil.* Op. cit., p. 16, pl. vi, figs. 17-18 *a*, *b*, 1848.

Diagnosis.—"*Form* rounded. *Both valves* marked with numerous fine broken lines radiating from the nucleus. *Area* wide, and slightly elevated. *Dorsal valve* slightly convex,[1] irregularly wrinkled longitudinally on the side, with several spines, rather long, adpressed and directed forward on the back, erect and directed backward on the umbone and sides. *Ventral valve* somewhat concave. *Umbone* small and much impressed."[2] (King.)

Strophalosia Morrisiana is undoubtedly closely related to the Russian species, *Strophalosia* (*Productus*) *Cancrini* of De Verneuil; but the following tabular comparison will show that both species possess certain well marked distinctive characters.

S. Morrisiana.	*S. Cancrini.*[3]
Slightly convex.	Very convex.
As wide as long; often wider.	Longer than wide.
Lateral slopes gradually inclining, and plicated longitudinally.	Lateral slopes rapidly inclining, and plicated transversely.
Area decidedly obvious.	Area scarcely perceptible.[4]

There appears to be some other differences, as in the striæ and spines, and in the form of the small valve; but these I cannot insist on, in consequence of having no specimens by me of the Russian, to compare with the English species.

Two varieties of *Strophalosia Morrisiana* occur in the Permian rocks of Durham. One has the large valve slightly convex, with a very small umbone; and appears to be confined to Tunstall Hill (this variety is represented in Plate XII, figs. 18, 19): in the other, which is rather common at Humbleton Quarry, the corresponding valve is more rounded, and the umbone more prominent (it is represented in the same

[1] Incorrectly printed in my 'Catalogue' "roundly convex."

[2] Catalogue, p. 9, 1848.

[3] Vide Geol. Russ., vol. ii, pp. 273-5, pl. xvi, fig. 8 *a*, *b*, *c*; pl. xviii, fig. 7.

[4] The area, which I presume exists, appears to be so small that it has escaped the observation of M. de Verneuil.

plate by figures 20, 21, 22, 23, 24, 25, 29, 30): possibly they are specifically distinct:[1] and it is this idea which causes me to be particular in stating, that the Tunstall Hill form must be considered as the type of the species. The variety *Humbletonensis* appears to graduate the latter into the *Strophalosia Cancrini*, which, however, in addition to the other distinguishing characters already noticed, has its large valve too much vaulted to be confounded with the form in question.

Strophalosia Morrisiana, considered in all its modifications, may be readily distinguished from the two species last described. It is decidedly more regular in form than *S. Goldfussi*; and the area, although wider, is not so high (vide Pl. XII, fig. 19): the spines too, are not so numerous. It agrees with *S. excavata* in form and in the size of the area;[2] but in this species the spines are far more numerous and more regular in their arrangement; though in the latter respect there is a simulation on the part of *S. Morrisiana*. The present one differs from both species in having the valves striated, and the spines adpressed.

There is a singular peculiarity in this species requiring to be mentioned. I have seen several specimens of the rounded variety, found at Humbleton Quarry, appearing as if trivalved; but whether it is due to accidental circumstances I am not prepared to say: its occurrence in several specimens seems to negative this conclusion. I have had represented in Plate XII, figs. 20, 21, 22, 23, 24, two of my specimens displaying this character; leaving it to be cleared up by future researches. Full grown specimens of the same variety occasionally show the anterior margins arching and gaping so as to approximate to the form of the circular or elliptical orifice of *Productus proboscideus* before its tube becomes developed. I still think that this singular modification has been caused by the flowing in and out of the currents which supplied the mollusc with the necessary quantity of nutriment and fresh air.[3]

In making the *Orthothriæ lamellosus* of Geinitz synonymous with this species, notwithstanding the former is stated to be without spines on the small valve, I have been influenced by certain of my specimens displaying lamellæ on this valve somewhat similar to those represented in the 'Versteinerungen,' at figures 15 *a*, 16, 17 *a*, 21, in Plate V. The fossils identified by Dr. Geinitz (vide Pl. VI, figs. 16, 17, 18) with the *Strophalosia Cancrini*, I readily recognise as belonging to *S. Morrisiana*.

[1] I designate the Humbleton form *Strophalosia Morrisiana*, var. *Humbletonensis*: in case it should be found to be a distinct species, the varietal may be conveniently used for the specific name.

[2] The area is represented too high by nearly one half in the restored medio-longitudinal section represented in Plate XI, fig. 21; further, the spines are too much elevated, and the large valve is rather too convex for the typical form.

[3] "Koninck, from an examination of *Productus proboscideus*, supposes that it (the genus generally) was attached by means of fibres passing out of the anterior opening, which would compel us to conclude that the genus did not belong to the *Palliobranchiata*. Instead of the anterior tubular opening of *P. proboscideus* subserving such an office, I cannot but think that it simply served as a passage for the ingress and egress currents." (Vide Annals and Mag. of Nat. Hist., vol. xxiii, p. 93.)

Strophalosia Morrisiana occurs rarely at Tunstall Hill, Tynemouth Cliff (in Breccia), Claxheugh, Dalton-le-Dale, Ryhope Field-House Farm; and rather commonly at Humbleton Quarry. A specimen, in the York Museum, of apparently the same species, was found at Nosterfield. I suspect it also occurs at Ferry Bridge (vide Phillips in 'Philosophical Magazine,' N. S., vol. iv, p. 401, 1828). In Germany it occurs at Milbitz and Corbusen (Geinitz, 'Versteinerungen,' p. 16). Unless some of the fossils assigned to its related form (*Strophalosia Cancrini*) be the same, it would appear to be absent in the Permian deposits of Russia.

STROPHALOSIA PARVA, *King*. Plate XII, fig. 33.

Diagnosis.—Form irregularly circular marginally. *Large valve* somewhat convex: umbone very small, and much impressed: *spines* numerous, long, and closely packed: *area* very small. Rarely exceeding a quarter of an inch in diameter.

I have felt considerable difficulty in deciding whether this is the young of any of the former species, or a distinct one; but after a careful examination of a number of specimens, I have been led to adopt the latter conclusion. *Strophalosia Morrisiana* and *S. Goldfussi* are the only species to which it is likely to be referred; but its umbone is much more impressed, and its spines are decidedly more numerous and more elevated, than in the first: with *Strophalosia Goldfussi* the present species agrees somewhat in the profusion and direction of its spines; but in the former the umbone, although very much impressed, is more prominent.

Its habit of adhering to the inside of other shells (generally *Productus horridus*) has already been noticed. The umbone (vide Plate XII, fig. 33 *a*) is the part by which the shell was attached: the spines in this region were also thus subservient, as proved by their mode of spreading over the inside of the shell to which they adhered, and following its curvature: the remaining spines, those on the frontal slope of the valve, were free and straight; they also struck off from the surface of the valve at a considerable angle, and extended considerably beyond its margin,—all of which characters are fully displayed on a specimen which I have lately procured, but at too late a period for its being figured in the present work.

Strophalosia parva has only occurred to me in the shelly limestone of Humbleton Quarry.[1]

[1] I cannot conclude the *Productidæ* without noticing an observation of Dr. Thomson's, leading to the belief that Mr. James Sowerby had recognised nearly all the species of this family herein described: "Mr. Sowerby considers that he is able to distinguish no fewer than casts of five species of Productus in the specimen which I brought from Humbleton Hill." (Annals of Philosophy, vol. iv, p. 18, 1814.)

Family Strophomenidæ, *King*, 1846.

This family of Sarcicobrachial Palliobranchs, as will be seen by a reference to the Synoptical Table, embraces a number of genera, most of which *appear* to be furnished with slightly distinctive testaceous characters,—as the presence of spines on the hinge—a closed, or an open fissure—some peculiarity in the dental plates—a twisted, or an incurving beak. All the known genera are dentigerous, areagerous, and, with one exception (Chonetes), unprovided with spines:[1] they are generally characterised with large pallial vessels, which become minutely divided at the margin of the valves.

Most of the genera were in existence during the earliest organic period,—the Silurian; they gradually decreased in number, however, during those immediately succeeding, particularly the carboniferous; after which, and to the Jurassic period, they were represented by only a few straggling forms,—concluding from the single known Permian *Streptorhynchus* (*Terebratulites*) *pelargonatus*, the only known (?) Triassic *Streptorhynchus* (*Spirifer*) *spurius*, Münster, and the solitary Jurassic *Strophomena* (*Leptæna*) *Liasina*, Davidson.

Having in some respects modified my views on this family, compared with those given in my paper on the 'Palliobranchiata,' I purpose, before describing the next species, to make a few remarks on the strophomenideal genera of other writers, and those proposed by myself.

Rafinesque was the first to found a genus for shells belonging to this family. Whether his *Strophomena* were ever published by himself, or it first appeared under the editorship of some other author, I have not been able to ascertain; but this is certain, that the genus was described by M. de Blainville, in his 'Manuel de Malacologie,' 1825, and afterwards in the 'Dictionnaire des Sciences Naturelles,' t. li, 1827, in both of which it is typified by the American *Strophomena rugosa*, Raf., which, from its general form, and its large valve being concave, and the opposite one convex, I have little doubt is identical with the recently proposed *Strophomena* (*Leptæna*) *planumbona* of Hall.[2] Bearing in mind the characters of its specific type, it will be necessary to consider the genus *Strophomena* to comprise such shells as *S. alternata*, Conrad., *S. Dutertrii*, Murch., *S. euglypha*, Dalman, *S. plano-convexa*, Hall, and several others,

[1] *Schizophoria resupinata* appears to have had a tendency to become spiniferous.

[2] Vide Palæontology of New York, vol. i, p. 112, pl. xxxi *B*, fig. 4; and Bull. de la Soc. Géol. de France, 2me série, t. v, pl. iv, figs. 3 *a*, *b*, *c*, *d*. In my paper on the 'Palliobranchiata,' it is stated that *Strophomena rugosa* "is evidently closely allied to, and congeneric with, *Leptæna alternata*:" Mr. Sharpe gives a more exact account of it as regards form, in stating that the former, "having the dorsal valve concave, limit us to the group of which *Orthis umbraculum* may serve as the type." (Vide Geol. Journ.; vol. iv, p. 178.) From a recent examination of the figure in the 'Dict. des Sciences Naturelles,' I have become convinced that *Strophomena rugosa* has the large valve concave, which is also rendered clear by the following diagnosis: "Coquille bombée en dessous, et dont la valve supérieure est un peu concave et chargée de petites stries rayonnantes." (Loc. cit.)

most of which are plano-convex, or concavo-convex medio-longitudinally (indifferently as regards which valve); and more or less semicircular marginally; and have strong regular valves; thick curving dental plates; the point of the umbone occasionally foraminated; and the fissure more or less covered with a deltidium.[1]

Several of the foregoing characters distinguish *Strophomena* from *Leptæna* (= *Leptagonia*, M'Coy), a genus subsequently (1827) founded by Dalman on the *Producta rugosa* of Hisinger, and improperly made the receptacle for shells belonging to the former, both by Dalman himself, and many palæontologists of the present day. Considering *Leptæna* to be typified by the shell last named, this genus, although agreeing in some respects with *Strophomena*, obviously differs from it in having an open fissure;[2] the valves geniculated in front, and transversely wrinkled;[3] and the umbone often furnished with a foramen. *Leptæna* clearly embraces such shells as *L. analoga*, Phill., *L. semiovalis*, M'Coy, *L. plicotis*,[4] M'Coy, *L. nodulosa*, Phill., and *L. multirugata*, M'Coy.

There are many fossil shells belonging to the present family, such as *Productus comoides*, J. Sow., *Plectambonites oblonga*, Pander, *Orthis ornata*, Eichwald, and a few others, which some may be disposed to regard as militating against the distinctiveness of the last two genera; but I am more inclined to consider certain of them to be either simulating or merging forms, and the remainder as typical of undescribed genera.

At the same time Dalman instituted *Leptæna*, he proposed the genus *Orthis*, describing it, as is too often the case, from a number of very different shells, though agreeing in some of their characters. The diagnosis of the genus is as follows: "Testa inæquivalvis, æquilatera; valva minori subplana, majori subconvexa. Margo cardinalis rectilineus, latus, foramine deltoidea sub nate valvæ majoris. Valva major dentibus duobus subcardinalibus internis, longitudinalibus, compressis."[5] Dalman, in placing nine species in the genus, evidently entertained the idea that they had all an open fissure, and were congeneric forms; but what is the fact?—they belong to four distinct genera; viz., *Orthis*, *Chonetes*, *Orthisina*, and *Schizophoria*; and it is very doubtful whether more than two or three species have an open fissure.[6] It may be

[1] A species pointed out to me by Mr. T. Davidson, and named *Strophomena latissima*, Bouchard Chanteraux, does not appear to have had either a deltidium or fissure;—probably it possessed the former in the young state.

[2] Mr. Sharpe, who objects to the separation I formerly proposed between *Strophomena* and *Leptæna*, overlooks my urging, as one of the distinctive characters of the last genus, the open fissure seen in all its species. (Vide Ann. and Mag. Nat. Hist., vol. xviii, p. 38; and Geol. Journ., vol. iv, p. 179.)

[3] Some species of *Strophomena* simulate *Leptæna* in being transversely wrinkled. There is an approach to the same character in the singular *Strophomena* described by De Verneuil under the name of *Leptæna Loveni*. (Vide Bull. Géol. Soc. de France, 2me série, t. v, pl. iv, fig. 5 *a*, *b*, *c*, *d*.)

[4] Is the large valve of *Leptæna plicotis*, the concave one? (Vide Synopsis of the Silurian Fossils of Ireland, pl. iii, fig. 5.)

[5] K. Vet. Acad. Handl. p. 26, 1827.

[6] As a further reason for not attending to the characters given by Dalman, it may be stated that 1 the so-called Orthises figured in Hisinger's 'Lethæa Suecica,' are represented with an open fissure—even *Orthis pecten*.

asked, what is to be done in such a case? My answer is—abandon the diagnosis, as it has evidently been drawn upunder an erroneous impresssion, and attend solely to the characters of the species first described under the head of the genus,—the one named *Orthis pecten* (= *Anomia pecten*, Linnæus).

Typifying *Orthis* with the shell last noticed, the genus becomes restricted to such species as *O. arachnoidea*, Phill., *O. crenistria*, Phill., *O. eximia*, Eichwald, and *O. applanata*, Salter,[1] which have generally thin valves; the fissure closed with a deltidium; and slender, isolated or projecting dental plates.[2] The thinness of its valves, the character of its dental plates, and the absence of a foramen, distinguish *Orthis* from *Strophomena*, into which on the one hand it undoubtedly passes, while on the other, it graduates into M. A. d'Orbigny's *Orthisina*.

We owe to M. de Verneuil the fullest details on the large assemblage of fossil species usually placed in the genus *Orthis*; and it is entirely to his researches that we are indebted for a knowledge of the two great groups to which these species are referable —the *Arcuato-striatæ* (including species with the fissure generally open), and the *Recto-striatæ* (embracing those having the fissure closed with a deltidium). It is much to be regretted, that when this accomplished palæontologist was describing those fossils in the great work on 'Russia and the Ural Mountains,' he did not elevate these groups to the rank of genera; for it is quite evident that each one possesses characters of sufficient weight and importance to constitute a generic diagnosis. As it is, others, availing themselves of the ample materials thus prepared for them, have been led to institute genera, with certain modifications, for the groups first pointed out and defined by M. de Verneuil. Thus, M. A. d'Orbigny has already proposed the genus *Orthisina*, typified by *Gonambonites plana*, Pander, for several species of the group *Recto-striatæ*; while I have been induced to station the remainder in *Orthis*, and to institute the genus *Schizophoria* for the group *Arcuato-striatæ*, adding to it certain aberrant species.

[1] There are doubtless many species of *Orthis*, even restricted as this genus is in the text, at present distributed in *Leptæna*, *Strophomena*, &c.; but without a knowledge of their internal parts, they cannot with any safety be instanced as examples under the present head.

[2] I am in a great measure indebted to Mr. D. Sharpe, M. J. W. Salter, and Mr. T. Davidson (vide 'Quarterly Journal of the Geological Society of London,' vol. iv, part i, pp. 178-80; 'Memoirs of the Geological Survey of Great Britain,' vol. ii, part i, pp. 371-81; 'London Geological Journal,' vol. i, pl. xii and xiii; 'Bulletin de la Société Géologique de France,' 2^{me} série, t. v, p. 309, &c.) for information qualifying the conclusion I have arrived at respecting the distinctiveness of the shells here placed in *Orthis* and *Strophomena*. I agree with Mr. Sharpe as regards most of the characters with which he has invested the *Anomia pecten* of Linnæus, and the distinctiveness he has pointed out between it and my present Strophomenas (his Leptænas); we differ, however, as to the generic names which these two groups ought respectively to bear,—my Orthises being termed Strophomenas by Mr. Sharpe, and my Strophomenas, Leptænas. It would have afforded me much pleasure to have agreed with Mr. Sharpe in this respect; but my differing from him is entirely through being firmly persuaded that the rule I have throughout adhered to in this work, and elsewhere noticed, is the best calculated to divest generic nomenclature of its present confusion.

The genus *Schizophoria*[1] I propose to typify with the *Conch. Anom. resupinatus* of Martin, and to provisionally characterise it as having an open fissure, often rounded umbones, large punctures,[2] and the valves in general arcuately striated in the cardino-lateral regions. The genus thus characterised and typified readily resolves itself into a receptacle for most of the shells which M. de Verneuil has included in his groups *Sinuatæ*, *Arcuato-striatæ*, and *Plicosæ*.[3]

Since the period referred to, Mr. T. Davidson, besides rendering much valuable aid as regards the genera just discussed, has thrown considerable light on certain shells, the affinity of which were previously involved in the greatest obscurity. It is now clear, from the figures and descriptions published by this learned brachiopodist, that the *Anomia biloba* of Linnæus, and the *Terebratulites biforatus* of Schlotheim, are not Spirifers as they have generally been considered, but species typical of new genera allied to the last-described genus, and belonging to the same family,—*Strophomenidæ*. Impressed with this view, I here take the opportunity of instituting for these shells the following two genera.

Platystrophia,[4] King.—Type *Terebratulites biforatus*, Schlotheim.

Diagnosis.—A Strophomenidia; widest in the transverse direction; tumid; sub-æquivalve; plicated or striated; with large punctures, and a wide bi-areagerous hinge. *Umbones* prominent, strongly incurved, and approximating. *Areas* with an open fissure. *Large valve* deeply sinuated medio-longitudinally.

Besides the typical species, this genus embraces *Platystrophia Tcheffkini* (*Spirifer id.*), De Vern., *P. dentata* (*Porambonites id.*), Pander, *P. costata* (*Porambonites id.*), Pander, and *P. terebratuliformis* (*Spirifer id.*), M'Coy, all of which belong to the Silurian period.

Dicælosia,[5] King.—Type, *Anomia biloba*, Linnæus.

Diagnosis.—A Strophomenidia; deeply constricted medio-longitudinally; striated; widest at its anterior half; inæquivalved; and furnished with a narrow bi-areagerous hinge. *Umbones* slightly gibbous. *Area of the large valve* with an open fissure.

The published species of this genus are few in number, and appear to belong

[1] From σχιζω, I split, and φορεω, I carry.

[2] The species typical of the genus has a punctated structure. M. de Verneuil's *Schizophoria punctata* (*Orthis id.*) possesses this character (vide Bull. Géol. Soc. de France, 2me série, t. v, p. 35, pl. iv, fig. 8); and Mr. Morris has noticed it in *Schizophoria elegantula* (*Orthis id*), Dalman (vide Geol. Journal, vol. ii, p. 389).

[3] It is extremely probable that some of the shells included in these groups belong to uncharacterised genera.

[4] From πλατυς, wide, and στροφεω, to turn (as a hinge).

[5] From δις, twice, and κοιλος, a cavity; in allusion to the shell appearing as if separated into two cavities.

exclusively to the Silurian period. The type of the genus is peculiar to the Silurian rocks of Gothland; while *Dicælosia sinuata* (*Spirifer id.*), G. B. Sow., and *D. varica* (*Delthyris id.*), Conrad, are respectively characteristic of the equivalent deposits of Dudley and North America.

Passing over the genus *Chonetes*, originally established by Fischer de Waldheim (but subsequently elucidated by Dr. de Koninck) on the *Terebratulites sarcinulatus* of Schlotheim, and which is principally distinguished from *Strophomena* by having a row of spines running along the angle of the area, and an open fissure, I propose in the next place to notice another generic group of more immediate interest in connexion with the present Monograph.

Genus *Streptorhynchus*,[1] King.

Diagnosis.—A Strophomenidia; inæquivalved; striated or ribbed; with the hinge approximating or equal to the width of the valves. *Umbones* more or less divaricating; the large one irregularly twisted. *Fissure* covered with a deltidium. *Dental plates* small; projecting more at the base of the area than at its apex.

Type, *Terebratulites pelargonatus*, Schlotheim.

This genus, which consists of a small number of known species, is allied to *Orthis* and *Orthisina;* but it differs from both in the peculiar twisted character of its umbone, and the smallness of its dental plates. As regards the last character, the dental plates in the genera just noticed are the very reverse of those prevailing in the genus under consideration; as in *Orthis* (and it is the same with most of the Palliobranchiate genera furnished with these structures) they project more at the apex of the area (occasionally extending considerably into the umbonal cavity) than at its base, that is, immediately adjoining the teeth,[2]—which is evidently consequent on the former portion gradually increasing, in a forward direction, as the shell advances in age; whereas in *Streptorhynchus* they are more projecting at the base of the area than at its apex, where they still retain their original size,—proving that they have no growth independent of the increment of the teeth.

Comparing *Orthis arachnoidea*, and *O. crenistria*, Phillips, with *Streptorhynchus senilis* (*Spirifera id.*), Phill., this genus would seem to be aberrant from the normal Orthises.

Streptorhynchus senilis, Phill., *S. pelargonatus*, Schl., and *S. spurius* (*Spirifer id.*), Braun., are the only forms with which I am acquainted; and they respectively characterise distinct, yet consecutive formations,—the Carboniferous, Permian, and Triassic.

[1] From στρεπτω, I bend or twist, and ῥυγχος, a beak.

[2] Vide De Verneuil's figures of *Orthis eximia* and *O. Olivieriana* in Geol. Russ., vol. ii, pl. xi, figs. 2 *a* and 3 *b*.

STREPTORHYNCHUS PELARGONATUS, *Schlotheim.* Plate X, figs. 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28.

TEREBRATULITES PELARGONATUS, *Schl.* Akad Münch, vol. vi, pp. 28-9, pl. viii, figs. 21-24, 1816.
— — „ Schlotheim, Petrefactenkunde, p. 273, 1820.
— — „ Boué, Edin. Phil. Journ., vol. xii, p. 144, 1825.
(?) SPIRIFER MINUTUS, *J. de C. Sow.* Sedgwick, Trans. Geol. Soc., 2d series, vol. iii, p. 119, 1829.
(?) SPECIES 13, PLAGIOSTOMA (?) *J. de C. Sow.* Op. cit., p. 120.
TEREBRATULA PELARGONATA, *Schl.* Brongniart, Tab. de Ter., p. 423, 1829.
— — „ De la Beche's Geol. Man., Germ. Transl., p. 459, 1832; 3d Eng. Ed., p. 573, 1833.
(?) SPIRIFER MINUTUS, *J. de C. Sow.* Op. cit.
(?) — — „ Phillips, Encyc. Met., vol. iv, p. 617, 1834.
TEREBRATULA PELARGONATA, *Schl.* Loc. cit.
ORTHIS LASPII, *Von Buch.* Ueber Delthyris, p. 62, 1834.
— PELARGONATA, *Schl.* Quenstedt, Wiegmann's Archiv, vol. ii, 1835.
— LASPII, *Von Buch.* Mém. Soc. Géol. de France, t. iv, pp. 210-11, 1840.
TEREBRATULA PELARGONATA, *Schl.* Morris, Catalogue, p. 135, 1843.
ORTHIS — „ De Verneuil, Bull. Soc. Géol. de France, 2me série, vol. i, p. 29, 1844.
— — „ Geol. Russ., vol. i, p. 222, 1845.
— — „ Geinitz, Grundriss, p. 517, pl. xxii, fig. 6, 1846.
— — „ King, Catalogue, p. 8, 1848.
— — „ Howse, Tran. T. N. F. C., vol. i, p. 255, 1848.
— — „ Geinitz, Versteinerungen, p. 13, pl. v, figs. 11-15, 1848.

Diagnosis.—Terebratulæform; about half an inch long; finely radiately ribbed; posterior half, including the hinge line, a little less in width than the anterior half. *Large valve* obliquely sub-conical; sloping rapidly from the umbone to the front. *Umbone* projecting, irregularly twisted, and occasionally a little incurved. *Area* generally higher than wide; with a prominent deltidium, and obtusely rounded ridge-like dental plates. *Small valve* slightly rounded medio-longitudinally, and of a subquadrate form marginally; with a shallow median furrow, a small umbone, and a rudimentary area.[1]

[1] The following is M. Von Buch's description of this shell under the name of *Orthis Laspii:* "De la grossière d'une noisette. Largement carinée, avec un crochet peu courbé. La plus grande hauteur de la valve dorsale, avec une faible pente ascendante, est dans le milieu de la longueur. Les arêtes latérales forment des deux côtés un arc de cercle; le front est *plus large* que la charnière. La valve ventrale, avec une *natis elevée,* se creuse depuis le milieu en un large sinus avec des côtés fortement divergents. Il se prolonge beaucoup du côté de la valve supérieure, avec une large base au bord, et des côtés courts. L'area est droite, détachée, beaucoup plus petite que la largeur, de 110 degrés. L'ouverture est cicatrisée. On ne voit pas d'area ventrale. Beaucoup de plis dichotomes, tranchants, sur la surface des valves; 20 à la natis,

The foregoing diagnosis is given—not because those published by Von Buch and Geinitz are imperfect—but simply, in consequence of a wish to describe this remarkably variable and interesting species as it occurs in England.

In the German specimens of *Streptorhynchus pelargonatus*, the umbone appears to be generally more incurved than in those found in this country, nearly all the latter I have seen having the umbonal point turned up, though not so much as it is in the specimen in Pl. X, figs. 21, 22. Concluding from the figures in the 'Versteinerungen,' this species appears to have attained a larger size in Germany than in England; but I have lately procured at Tunstall Hill a fine specimen, much larger than any figured in this Monograph, though not quite so large as those represented by Dr. Geinitz. The irregularly twisted character of its beak is well displayed in the specimens represented by figs. 23, 27. Both valves are beautifully marked with slight dichotomous ridges, radiating from the umbonal point, and curving round to the hinge line in the cardino-lateral regions, as characteristic of De Verneuil's group *Arcuato-striatæ*. The dental plates, represented in fig. 28 *a*,[1] are in the form of slightly-raised, obtusely-rounded ridges; the socket plates (*b*) are rather large, and they project divergingly into the cavity of the shell; and the boss, which is bilobed and erect, occupies the inferior half of the fissure between the dental plates. The shell has a punctated structure; as I have seen specimens, in the state of casts, exhibiting here and there numerous minute points, evidently casts of minute tubular perforations, and resembling, though on a smaller scale, what undoubtedly are casts of the latter in *Trigonotreta cristata*, hereafter to be noticed. The tubular perforations, or rather their casts, are larger in the umbonal region than in other places.

Streptorhynchus pelargonatus bears a striking resemblance to a fossil described by Dr. Braun, in Count Münster's 'Beiträge,' Heft iv, pl. ix, figs. 3 *a*, *b*, *c*, under the name of *Spirifer spurius:* it occurs in the (?) Trias Marls of St. Kassian; and is evidently closely allied to, and congeneric with, the present species.

The present species was described first by Baron Schlotheim, in the 'Denkschriften der Königlichen Akademie der Wissenschaften zu München,' in which are several unmistakable figures of it. The so-called *Spirifer minutus* noticed in Professor Sedgwick's paper, as occurring at Humbleton Hill, is, I strongly suspect, the same shell, since impressions of the latter, which might readily be supposed to belong to a minute Spirifer, occur occasionally in this locality. M. von Buch, describing the same species under the name of *Orthis Laspii*, in 1834, states that it was discovered by M. Laspe at

110 au bord. La plus grande largeur est au dessous du milieu de la longueur. Longueur, 100; largeur, 109; hauteur, 70; largeur du sinus, 0·78 de la largeur totale; largeur de l'area, 0·63." (Essai d'une Classification et d'une Description des Delthyris ou Spirifers et Orthis, par Léopold de Buch. Translated par Henri le Cocq, Mém. Soc. Géol. de France, tom. iv, pp. 210-11, 1840.)

[1] The internal parts of the specimen represented in pl. x, fig. 28, appear larger than they really are, in consequence of being incrusted with particles of foreign matter.

Röpsen, in the Zechstein. The next notice we find of it has reference to its English locality, and is by Quenstedt, in 1835, who recognised specimens among the fossils collected by M. von Buch at Humbleton Hill. It is also introduced by Mr. Morris in his 'Catalogue of British Fossils,' as occurring in the latter place.

Streptorhynchus pelargonatus occurs, though nowhere plentifully, at Humbleton Hill, Dalton-le-Dale, and Tunstall Hill, in the Shell Limestone; and at Tynemouth Cliff, in the Breccia. Geinitz states that it is found in the lower Zechstein of Röpsen, Corbusen, and Schmerbach; and in the Zechstein-dolomite of Könitz and Altenstein.

Order Sclerobrachia, Gray, 1848.

Diagnosis.—"The oral arms" (more or less) "supported by a shelly band arising from the hinder or cardinal edge of the ventral" (dorsal, nobis) "valve."[1] (Gray.)

This Order, distinguished from the last by the character above given, comprises two families, both of which had several representatives during the Permian epoch.

Family Hypothyridæ,[2] Morris, 1846.

Terebratulæ, *Auct.*
Tereb. plicatæ, *Von Buch*, 1833.
Terebratules plissées (*partim*), *Eudes-Deslongchamps*, 1837.
Cyclothyridæ (*partim*), *Phillips*, 1841.
Terebratulidæ (*partim*), *M'Coy*, 1844, *King*, 1846.
Rhynchonellidæ, *Gray*, 1848.

Diagnosis.—"The oral arms are elongate, fleshy, supported at the base by two short, hard, *diverging*, shelly laminæ, arising from the hinge-margin of the ventral valve."[3]

The members of this family have a decided approach in form to the ordinary *Terebratulidæ*, which has induced many authors to consider both as inseparable from each other; but the former differ from the latter in being generally radiately plaited, without a calcareous loop, and having generally "the beak acute, the perforation below it." (Phillips.)[4]

Mr. Gray was the first to distinguish the present group of shells, not only as regards separating it from its allies as a family, but to the extent of a sub-class,—

[1] Annals and Magazine of Natural History, 2d series, vol. ii, p. 437.

[2] Mr. Morris only considered the group bearing this name as a sub-genus. (Vide Quarterly Journal of the Geological Society, vol. ii, part. i, pp. 387-8.)

[3] Annals and Magazine of Nat. Hist., 2d series, vol. ii, p. 438.

[4] Dr. Carpenter places Hypothyrises in his non-perforated division of the Brachiopods; but punctures, though much more minute than those in *Terebratulidæ*, occur in every species that has passed under my observation. Punctures also occur in *Productidæ* and *Spiriferidæ*; in short, I doubt their absence in any Brachiopod whatever.

a step which I consider one of the most important that has of late been made in malacological classification.

I propose placing in this family the genera *Isorhynchus*, *Hypothyris*, *Camarophoria*, *Uncites*, and *Pentamerus;* but looking at such forms as *Hypothyris psittacea*,[1] Chemnitz, *H. excavata*, Phillips, *H. concinna*, J. Sowerby, *H. Wilsoni*, J. Sowerby, *H. acuminata*, Martin, *H. plicatella*, Dalman, and some others, which are for the present included in the same genus, it would appear to consist of more genera than those above named. M. Alcide d'Orbigny has indicated or described some, which may be admissible; but not being sufficiently acquainted with their characters, I can only make this passing allusion to them.

The genus *Hypothyris* was first proposed provisionally by Professor Phillips in 1842, for shells having the "beak acute, the perforation below it,"[2] and which had been previously distinguished (though not named) from the apically-foraminated Terebratulas by J. Sowerby, Von Buch, and Eudes-Deslongchamps.[3] The group to which the name was applied is sufficiently obvious; it is to be regretted, however, that Professor Phillips did not point out its type—a circumstance which induced me, when endeavouring to establish the group as a genus,[4] to make free in typifying it with the *Atrypa cuboides*[5] of J. de C. Sowerby.[6]

[1] M. A. d'Orbigny has made this species typical of his genus *Hemithyris;* but in what respect does it differ from the true Hypothyrises?

[2] Palæozoic Fossils, &c., p. 35.

[3] I was not aware, until my friend Mr. T. Davidson called my attention to the fact, that M. Eudes-Deslongchamps had published his remarkably correct (that is, for the period, 1837) 'Tableau Synoptique d'un Arrangement systématique des Brachiopodes fossiles des Terrains du Calvados;' otherwise it would not have been overlooked in my paper on the 'Palliobranchiata.' I perceive some of the divisions of this Tableau are equivalent with certain of the new genera I have proposed.

[4] Vide Annals and Magazine of Natural History, vol. xviii, p. 28.

[5] I was prevented placing the first species (*Terebratula proboscidialis*, Phill.) which Professor Phillips described under the head of the group, as the type of *Hypothyris*, from being uncertain as to whether or not it belonged to the genus.

[6] I feel it necessary to make a few remarks in this place on the name which is here applied to the present genus. Fischer de Waldheim in his 'Notice sur les Fossiles du Gouvernement de Moscow et sur les Coquilles fossiles dites Terebratules,' published in 1809, was the first to separate the plicated or sub-apically foraminated Terebratulas from those with an apical foramen, under the two divisions *Trigonella* and *Rhynconella*, each apparently respectively corresponding with the groups *Pugnaceæ* and *Concinnæ* of Von Buch; but they are so imperfectly characterised (a fault common to that period), and the type of each is so difficult to identify with any known species, that it must be evident to every one, these divisions, before they can be adopted, require to be entirely rearranged. Reverting for a moment to the types named by the celebrated Oryctographer of Moscow, I would ask, is anything satisfactorily known respecting the *Trigonella atoma*, and *Rhynconella loxia?* Has any one been able to identify these shells? What formation do they belong to? and where are their localities? The foregoing remarks have suggested themselves in consequence of some authors regarding Fischer de Waldheim's *Rhynconella*, as rearranged by M. A. d'Orbigny, to be the same as *Hypothyris:* this may, or may not be the case:—for my part I am not able to give an opinion on the matter, being quite unacquainted with what species the learned author of the 'Palæontologie

It is quite unnecessary at the present day to enter into any details proving the distinction between *Hypothyris* and *Terebratula*. In addition to what I have elsewhere published,[1] the subject has been ably elucidated by Mr. Morris ;[2] and no conchologist, I believe, has demurred to the separation.

Hypothyris appears to have withstood all the changes which organic nature has been subject to on our planet ; as species have lived and succeeded each other from almost the earliest organic period to the present moment. They were most abundant during the primary and secondary periods ; few are known to have existed during the tertiary; and only two species appear to be living at the present time. The one generally known, *Hypothyris psittacea*,[3] has an extensive geographical range in the northern hemisphere, having been found in the icy seas of the arctic circle, and on the coast of Northumberland.[4]

The next genus is now for the first time proposed for a singular group of shells which have long been without a proper standing place in our conchological systems.

Genus *Isorhynchus*,[5] King.

Type *Terebratulites æquirostris*, Schlotheim, as represented by De Verneuil in the 'Géologie de la Russie d'Europe,' vol. ii, pl. iii, fig. 1.

Diagnosis.—Sub-globular ; sub-æquivalved ; tumid behind, and compressed in front ; slightly areated ; generally striated ; and with large punctures. *Umbones* of nearly equal size ; that of the large valve foraminated at its apex. *Large valve* with two long

de France' has made typical of the former genus ; but this I can say, the name *Rhynconella* cannot supersede that of *Hypothyris* for a genus typified by the *Atrypa cuboides*,—for this reason, that such a genus (without going back to the year in which it was provisionally proposed by Professor Phillips, which is not allowable in the present case) was defined both by Mr. Morris and myself, and also typified by one of us, two years previously to M. A. d'Orbigny's resuscitating the Waldheimian name *Rhynconella*. In making these observations I wish it to be understood, that I shall most cordially agree with what M. A. d'Orbigny has done connected with *Rhynconella*, provided it does not clash with *Hypothyris* : it is very possible this is the case, considering that this author has been describing cretaceous *Hypothyridæ*, which have certainly some appearance of being generically distinct from the normal species of the Palæozoic rocks ;—but I am not aware of the distinction having yet been established.

[1] Vide Ann. and Mag. of Nat. Hist., vol. xviii, pp. 32-6.

[2] Quarterly Journal of the Geological Society, vol. ii, part i, pp. 382-9.

[3] The other species, named by Mr. G. B. Sowerby, *Terebratula nigricans*, and described in his beautiful 'Thesaurus Conchyliorum,' has not yet had its locality determined.

[4] Vide Ann. and Mag. of Nat. Hist., vol. xviii, p. 238 ; and Forbes and Hanley's 'British Mollusca,' vol. ii, p. 348. The specimens which I procured on the coast of Northumberland were an entire shell and a rostral valve ; the former, which is the original of the figures in the 'British Mollusca' (pl. lvii, figs. 1, 2, 3), is now in Mr. J. G. Jeffrey's rich collection of British shells, and the latter I presented to the Museum of the Natural History Society of Northumberland, Durham, and Newcastle-on-Tyne.

[5] Etym. ἴσος, equal ; ῥύγχος, a beak—in allusion to the nearly equal size of the umbones.

more or less diverging dental plates; and a median sinus. *Small valve* with two long more or less diverging socket-plates.[1]

Isorhynchus embraces, with perhaps the exception of the so-called *Spirifer Tcheffkini* all the species forming the section *Equirostres* of De Verneuil's *Abnormal Spirifers*. Although placed in the present family, I am not decidedly of opinion that the collocation is a correct or natural one: there are obviously many difficulties preventing the proximate affinities of the genus being satisfactorily determined. Should *Spirifer Tcheffkini* really be a congeneric form, no very serious argument could be urged against *Isorhynchus* being considered one of the *Strophomenidæ*, and closely allied to *Platystrophia;* but its foramen, dental and socket-plates, and general form are strongly in favour of its being placed in *Hypothyridæ;* while, on the other hand, it has apparently some relationship to certain genera (*Retzia* and *Atrypa*) of *Spiriferidæ*.

Isorhynchus appears to have been one of the earliest created groups, being found in, and apparently confined to, the lowest Silurian beds of Russia and Norway: this circumstance, and its possessing characters which seem to relate it to three widely distinct families, render the genus of the utmost importance in a philosophical or morphological point of view.

Possessing no precise information on the genus *Uncites* proposed by De France, and having nothing to add to the description I have elsewhere published of *Pentamerus*,[2] I purpose in the next place to proceed with the remaining genus requiring consideration in connexion with the present family.

Genus *Camarophoria*,[3] King, 1844.

Terebratula, *Auct.*

Diagnosis.—Hypothyriform; coarsely fibrous, and minutely punctured; with a small open fissure. *Large valve* with the dental plates conjoined at their upper margin, forming an arch-shaped process, which is attached by its crest to the (ventral) medio-longitudinal plate. *Small valve* with two long slender processes striking off from the centre of the crural base—a horizontal plate,—and curving up towards the opposite valve; also a spatula-shaped process originating a little below the latter, projecting considerably forward with an upward curve, and supported by the (dorsal) medio-longitudinal plate.

Type, *Terebratula Schlotheimi*, Von Buch.

[1] The above diagnosis has been drawn up both from my own observations on some specimens kindly presented to me by M. de Verneuil, and the description published by him of the corresponding group, *Equirostres*, in Geol. Russ., vol ii, p. 128.

[2] Vide Annals and Magazine of Natural History, vol. xviii, pp. 83-7.

[3] Etym., καμαρα (an arched) chamber; φωρεω, I carry. I originally spelled the name *Camerophoria*, but I feel much pleasure in adopting the correction made in it by M. Herrmannsen, in his 'Indices Generum Malacozoorum Primordia,' p. 161, 1846.

In a paper published by myself in 1844, I announced my intention of forming a new genus, under the name of "*Camerophoria*, for a shell approximating to *Pentamerus* in some points of its internal structure;"[1] but it was not until 1846 that an opportunity occurred to me of entering into any description of its distinctive characters.[2] The details then published have in general been confirmed by observations I have recently made; so that little is required at present but to transcribe them with such alterations as are rendered necessary by the arrangements and modified nomenclature adopted in this work.

Describing from the type of the genus, and its ally *Camarophoria multiplicata*, the large valve possesses a fissure (Pl. VII, fig. 13 *a*), which is open, and in general only exposed in young individuals; in old ones it becomes dilated at its base, and is then occupied with the point of the umbone of the opposite valve, as in *Pentamerus* (*galeatus*). The dental plates pass from the fissure, one on each side of it, to nearly a third of the length of the shell (Pl. VIII, figs. 3, 4 *a*): they conjoin at their superior margin, so as to form an arch-shaped process, the crest of which is attached to a low vertical plate (evidently the homologue of what has elsewhere been termed the ventral medio-longitudinal plate), which gradually becomes higher as it passes from the apex of the fissure to the anterior part of the umbonal cavity (Pl. VIII, figs. 3, 4 *b*). The arch-shaped process, and its supporting or suspending plate, correspond in every respect, except in degree, with the apophysary system belonging to the large valve of *Pentamerus*.

In the opposite or small valve, the space between the dental sockets is occupied with a horizontal plate (Pl. VIII, figs. 3, 5 *c*) attached on one side to the hinge, and free on the other: its centre is occupied with a small protuberance marked with lines or striæ (Pl. VIII, figs. 3, 4, 5 *d*). This plate is considered to be the equivalent of the *crural base*, and the protuberance, the counterpart of the *boss or cardinal muscular fulcrum* of other genera.

From the margin of the crural base arise two slender processes, one on each side of, and immediately adjoining, its centre (Pl. VIII, figs. 3, 4 *g*): they curve upwards to nearly the anterior end of the arch, just within touching it. These processes, which I am disposed to regard as the homologues of the two curving plates (crura of the loop) that strike off from the hinge of the small valve in *Hypothyris* (*psittacea*), appear to have been hollow, and to have passed through the crural base; for occasionally casts of their lower portion are seen, like two threads, starting from the centre of the space occupied by the crural base, when the substance of the latter has been removed through fossilization. Immediately below the structures just noticed, a large spatula-shaped process is seen to originate and project with a slight upward curve nearly to the centre of the shell (Pl. VIII, figs. 3, 4, 5 *e*): it becomes considerably dilated towards the free

[1] Annals and Magazine of Natural History, vol. xiv, p. 313.

[2] Idem, vol. xviii, pp. 89-91.

extremity; is concave on its upper surface; and has a ridge passing along its median line. The ridge forms the upper portion of a high vertical plate, which supports the spatula-shaped process, and extends from the under side of the crural base to within a short distance of the centre of the shell (Pl. VIII, figs. 3, 4, 5*f*), and which is evidently the counterpart of the dorsal medio-longitudinal plate already noticed. (Vide ante, p. 70.)

In order to ascertain the use of certain processes in *Camarophoria*, it will be necessary to turn our attention for a short while to some other shells of the same class.

By examining casts of most species possessing dental plates separated from each other, it will be seen that the intervening space between these plates, from the scars thereon, has afforded attachment for certain muscles. Extending our researches to those shells in which the dental plates approximate more and more until they become united, as in certain *Strophomenidæ*,[1] it will be quite evident that the attachment of the muscles has been gradually removed from the surface intervening the dental plates, to that of the plates themselves when they became united. The scars visible on the saucer-shaped process of *Leptæna analago* lead to the same conclusion. Now as there are no muscular impressions on the surface of the large valve of *Camarophoria*, and it being certain that its arch-shaped process has resulted from the union at their upper margin of the dental plates, it clearly follows that this arch shaped process has served as a muscular fulcrum.

Turning our attention to casts of *Hypothyris acuminata*, or any of its immediate allies, there will be seen on the posterior half of the small valve, on each side of its median line, certain elongated impressions, which are obviously due to muscular attachment: this shell, it must be borne in mind, has no spatula-shaped process,—only the homologues of the two crura of the loop characteristic of *Hypothyris* (*psittacea*). Possessed of these facts, our attention is naturally drawn to the small valve of *Camarophoria:* but here we search in vain for any scars corresponding either in form or position with those of *Hypothyris acuminata:* they could not occur on the parts where they are situated on the shell last noticed, in consequence of the spatula-shaped process overspreading them: this circumstance, and the fact that they are not visible on any part not overspread by the spatula-shaped process, or unoccupied by other structures, show that the muscles were nowhere attached to the surface of the small valve: hence it may be safely inferred that the spatula-shaped process of *Camarophoria* has been a muscular fulcrum—a conclusion powerfully supported by the elevated apophysis in the small valve of *Leptæna analago* (vide Pl. XX, fig. 7 *c*, *d*) having been for a certainty a correspondingly subservient structure.

The vascular system of *Camarophoria* appears to be nearly similar to that of

[1] Vide Geology of Russia, vol. ii, pl. xi, fig. 2 *a*, and pl. xii, fig. 3 *g*.

Hypothyris, at least, taking as an example *H. acuminata*, in which the vessels, as exhibited on casts, have been distributed over the mantle pretty much the same as in *Camarophoria multiplicata* (vide Pl. VIII, figs. 6, 7). The veins (*i*) and the arteries (*j*), which the former are occasionally seen to inclose on sharp casts, have been similarly disposed on both lobes of the mantle. In each valve there are two main trunks, which first make their appearance at the anterior end, and on each side of the medio-longitudinal plates (*f*); but evidently, from their impressions occasionally being seen running down each side of the plates, originating within or near the arch-shaped process of the one valve, and the spatula-shaped process of the other: they run forward for a short distance, then sweep round towards the cardinal region, and finally run forward again to nearly their origin, forming in this way two small, nearly complete circles, each of which is limited to the lateral half of the central region of the valves. In their circuit, the main trunks give off at regular distances on their outside several branches, each one of those in front and on the sides becoming thrice divided in its progress to the margin of the valves: near the margin of the mantle, these branches, it is probable, were more minutely subdivided.

I have never seen any of the vessels enlarged so as to induce the belief that they were ever charged with the genital organs, as is the case in certain *Terebratulidæ;* but from certain impressions which are occasionally observed within the vascular circles above described, and immediately adjoining the medio-longitudinal plates, I am led to believe that the latter were the seats of reproduction. Each of the main trunks of *Hypothyris acuminata* forms an ellipse, in the inside of which, but outside of the muscular scars, there are often seen similar genital-like impressions; and I consider the large lateral circles, circumscribed by a main trunk in the valves of *Leptæna analoga* (vide Pl. XX, figs. 6, 7), to be the localities of the reproductive organs.

In *Camarophoria*, when the shell has attained a proper size, its margins, instead of meeting each other, are acutely eflected, or, in other terms, they strike off horizontally, and continue to grow in this direction, so that the shell becomes furnished with two wide marginal expansions running out in a horizontal direction, and parallel to each other (vide Pl. VII, figs. 20, 21; Pl. VIII, fig. 8). In the specimen, represented in fig. 8, Pl. VIII, the marginal expansions exhibit some vascular impressions; but they do not display any appearance of the vessels being minutely divided. The lamellæ of certain Bivalves (e. g. *Venus lamellata*, Lam., also certain Oysters) and Palliobranchs (e. g. *Discina ostreoides*, *Cleothyris* (*Atrypa*) *planosulcata*, J. de C. Sow., &c.) appear to be the same as the marginal expansions; but there is this difference,—the latter are only developed once, and when the shell attains a certain size, whereas in the former they are repeatedly developed during all stages of the shell's growth. It would therefore appear that nothing of the precise kind occurs in other shells, unless it be, as I strongly suspect is the case, the geniculated portions

of *Leptæna*, which may be regarded as only differing from the marginal expansions of *Camarophoria* in their direction, being turned upwards, considering the perforate valve to be the inferior one. Perhaps, as is the case with the geniculated portions of *Leptæna*, the marginal expansions constitute one of the generic characters of *Camarophoria:* this is a point to which I may be allowed to draw the attention of those who have an opportunity of fully studying the characters of the Carboniferous *Hypothyridæ*.

The histology of *Camarophoria* agrees with that of *Hypothyris*. The valves consist of closely-packed, capillary fibres, which pass through them at a very slight angle, following, at the same time, a radiate arrangement as they succeed each other from the umbones to the margins. The punctures are extremely minute, and appear to intersect the fibrous tissue nearly at a right angle to the surface of the valves.

Camarophoria, in the apophysis of its large valve, undoubtedly possesses a striking resemblance to *Pentamerus;* and as it appears to have succeeded the latter genus *in time*, I am disposed to regard both as being proximately related to each other. All that prevents my arriving at a positive conclusion on this point, is the dissimilarity existing between the apophysary system of their small valve; which, in *Pentamerus* consists of the two socket plates largely developed, and passing to a considerable distance into the cavity of the shell; whereas in *Camarophoria* it appears to consist of the medio-longitudinal plate equally as much developed, and expanded bilaterally at its free or upper margin. Perhaps a knowledge of the internal structure of some of the Pentameri described and figured by M. J. Barrande, in his paper 'Ueber die Brachiopoden des silurischen Schichten von Bohmen,' 1847, may destroy the dissimilarity just noticed by displaying the two plates of *Pentamerus* becoming gradually modified into the spatula-shaped process of *Camarophoria*.[1]

Although related to *Pentamerus*, *Camarophoria* is also closely allied to *Hypothyris*,—especially in form; the only difference is in their internal structures,—*Hypothyris* having the dental plates completely separated and divaricating, as in *Orthis*, which is well displayed in several casts before me of *Hypothyris pleurodon*, and some other species. The same amount of dissimilitude prevails between the apophysary system belonging to the small valve of both genera: in *Hypothyris* it simply consists of the homologues of the crura of the loop starting from within the *socket plates*, which are rarely developed to any extent, offering in this respect a striking contrast with the large size of the corresponding structures of *Pentamerus*.

Concluding from what is at present known, *Camarophoria* does not appear to have been numerous in species, nor to have had much chronological range. About half a

[1] Some of the so-called Spirifers figured by Kutorga in plate v of his paper entitled 'Beiträg zur Palæontologie Russlands,' may throw some light on the affinity existing between *Camarophoria* and *Pentamerus*.

dozen species belong to the carboniferous system;[1] while the three hereafter described, and perhaps one or two more, were characteristic of the Permian period.[2]

Camarophoria Schlotheimi, *Von Buch*, 1834. Plate VII, figs. 10 to 21; Plate VIII, fig. 8.

Eine Varietat der Terebratulites lacunosus, *Schl.* Taschenbuch, pp. 56-7, 1813.
Terebratulites lacunosus, *Schl.* Münch. Akad., vol, vi, p. 28, pl. viii, figs. 15-20, 1816.
— — Var., „ Petrefactenkunde, p. 267, 1820.
— — „ Boué, Edin. Phil. Journ., vol. xii, p. 144, 1825.
(?) "Plaited" Terebratula, *J. de C. Sow.* Sedgwick, Trans. Geol. Soc. Lond., 2d series, vol. iii, p. 119, 1829.
Terebratula lacunosa, *Schl.* Brongniart, Tab. de Terr., p. 423, 1829.
— — „ De la Beche, Geol. Man., p. 384, 1831; Germ. Transl., p. 459, 1832; and 3d Eng. Edit., p. 573, 1833.
— — „ Phillips, Encyc. Met., vol. iv, p. 615, 1834.
— Schlotheimi,[3] *Von Buch.* Ueber Terebrateln, p. 39, pl. ii, fig. 32, 1834.
— — „ Quenstedt, Wiegmann's Archiv, vol. ii, p. 79, 1835.
— — „ Le Cocq. Transl. of Von Buch, Mém. de la Soc. Géol. de France, T. iii, pp. 1838-9, pl. xiv, fig. 7, 1838.
— — „ Geinitz, Neues Jahrbuch, p. 640, 1841.
— — „ Morris, Catalogue, p. 134, 1843.
— — „ Geinitz, Gæa von Sachsen, p. 96, 1843.
— — „ De Verneuil, Bull. Soc. Géol. de France, 2me série, vol. i, p. 27, 1844.
— „ Geol. Russ., vol. i, p. 222; vol. ii, pp. 101-3, pl. viii, fig. 4 *a, b, c, d, e,* 1845.
— — „ Geinitz, Grundriss, p. 498, pl. xxi, figs. 4, 5, 1846.
Camarophoria — „ King, Ann. and Mag. Nat. Hist., vol. xviii, p. 28, 1846.

[1] Some of the Carboniferous species are noticed hereafter under the head of *Camarophoria Schlotheimi*. The shell identified by Dr. de Koninck with Professor Phillips's *Terebratula rhomboidea* appears to be a *Camarophoria:* I have seen in Mr. T. Davidson's collection, specimens which closely resemble *C. Schlotheimi*. Perhaps Kutorga's *Spirifer triplicatus* is of the same genus; and from what M. de Verneuil states (Geol. Russ., vol. ii, p. 396), the *Pentamerus plicatus* and *P. sella* of this author are evidently Camarophorias.

[2] I regret being unacquainted with De Verneuil's *Terebratula Geinitziana:* perhaps this allusion will be the means of calling attention to its generic position.

[3] Schlotheim, having included under the name *Terebratulites lacunosus*, three different species belonging to three different formations, the Silurian, Permian, and Jurassic, M. von Buch was induced to name those respectively belonging to the first two formations, *Terebratula borealis*, and *T. Schlotheimi*, leaving the Schlotheimian name for the Jurassic species.

Terebratula Schlotheimi, *Von Buch*.			Tennant, Strat. List, p. 88, 1847.
Camarophoria	—	,,	King, Catalogue, p. 7, 1848.
Terebratula	—	,,	Howse, Trans., T. N. F. C., vol. i, p. 252, 1848.
—	—	,,	Geinitz, Versteinerungen, p. 12, pl. iv, figs. 43-50, 1848.

Diagnosis.—The typical *Camarophoria*. Generally as wide as long; rarely exceeding five eighths of an inch in length or width; smooth; plain, and somewhat tumid in its posterior half; plicated or ribbed, and deeply sinuated in its anterior half; with from one to six generally dichotomous ribs in the sinus, or on its corresponding elevation, and the same varying number on the sides; of a sub-pentagonal form; pointed behind; and rounded in front. *Large valve* rather rounded in the umbonal region; depressed at the sides; and with the front or sinus portion considerably produced arcuately beyond, and falling below, the latter (considering this valve as the upper one): *fissure* small. *Small valve* with the median elevation high in front, and the sides rapidly sloping. *Marginal expansions* extending to about half the length of the shell.

Camarophoria Schlotheimi is a variable species,—not so much in its form as in the number of its ribs. Occasionally it is very much tapered behind, and longer than wide; whereas the general tendency is to the contrary. As regards variation in the number of its ribs, there are five or six well-marked forms depending on their number in the sinus: the ribs on the sides are also subject to the same variation: occasionally specimens occur without any ribs either in the sinus or on the sides, as exhibited in fig. 10, Pl. VII. I suspect that Dr. Geinitz has identified a shell belonging to the latter variety with the *Camarophoria superstes* of De Verneuil. I am also led to suspect that the shell which is identified in the 'Versteinerungen' with the *Terebratula Geinitziana* of the same author is a numerously plicated form of the present species. The principal varieties have been very truthfully represented by Mr. G. B. Sowerby, jun., in Pl. VII. With the exception of some slightly prominent lines of growth and a few obsolete longitudinal striæ, the surface of this species is remarkably smooth. The marginal expansions are slightly ribbed, the ribs being a continuation of those on the valves.

Camarophoria Schlotheimi closely resembles the *C. crumena*[1] of Martin, which

[1] When examining, in the Autumn of 1848, Mr. J. de C. Sowerby's valuable collection of fossil shells figured in the 'Mineral Conchology,' I was highly gratified with discovering that the shell represented in plate lxxxiii, fig. 3, and identified with the *Conchyliolithus Anomites* (*Crumena*) of Martin, belonged to the genus *Camaraphoria*. The specimen which originally belonged to Mr. Martin, resembles the one figured in the 'Petrefacta Derbiensia' (pl. xxxvi, fig. 4) so closely as to allow of little doubt existing of its being the original of the figure just cited. The others pecimens represented in the 'Mineral Conchology,' pl. lxxxiii, figs. 2, 2*, belong to a very different species, and evidently to the genus *Hypothyris*. The Gilbertsonian collection in the British Museum contains a card labelled *Terebratula plicatella*, Dalman, and mounting nine specimens with from three to five ribs in the sinus: no locality is given: they are undoubtedly Camarophorias: my notes state that they are identical with *C. Schlotheimi;* but I now suspect them to be the same species as the one noticed in the text, found in Weardale, Durham. I have also a memorandum stating that *C. crumena* occurs in the same collection.

appears only to differ from the former in being narrower and more acuminated behind. Occasionally, however, a variety of the present species occurs, which can scarcely be distinguished from *C. crumena:* in short, both species apparently merge into each other so completely, that many would be inclined to consider them as specifically inseparable. The Lamarckian might very reasonably instance them as proving proximate species to be modifications of each other; while, at the same time, his opponent might with equal reason contend for their being the result of a single specific creation. There is another species, undescribed, occurring in the Carboniferous Limestone of Weardale, Durham, and having a still closer resemblance to *C. Schlotheimi* in form; but its spatula-shaped process is decidedly more curved,—so much so, that its termination is not far removed from the anterior end of the arch of the large valve.

This species is a very common fossil at Tunstall Hill and Humbleton Quarry, and a less common one at Ryhope Field-House Farm, in the Shell-limestone. I procured a few specimens in the Breccia at Tynemouth Castle Cliff. Schlotheim first noticed it as occurring in the bituminous Marl-slate (Kupferschiefer) of Schmerbach. Geinitz and others record its occurrence in the Zechstein of Corbusen, Schwaara, Röpsen, Milbitz, Ilmenau, Sangerhausen, Schmalkalden, Schmerbach, and Kamsdorf. M. de Verneuil notices it as occurring in the Carboniferous Limestone of Mount Chéractau near Sterlitamak, at Sarana on the Ufa, and at Cosatchi Datche, in Russia.[1]

Camarophoria globulina, *Phillips.* Plate VII, figs. 22, 23, 24, 25.

Terebratula globulina, *Phillips.* Encyc. Met. Geology, vol. iv, pl. iii, fig. 3, 1834.
Camarophoria — „ King, Annals of Nat. Hist., vol. xviii, p. 28, 1846.
— — „ King, Catalogue, p. 7, 1848.
Terebratula corymbosa, *Howse.* Trans. T. N. F. C., vol. i, p. 253, 1848.

Diagnosis.—Sub-globular; rarely exceeding a quarter of an inch in diameter; smooth; slightly sinuated in front. *Sides* (looking down on the perforate valve) higher than the *front*, which falls considerably below the latter: *sides and front* more or less ribbed. *Ribs* sharp and simple. *Umbones* slightly projecting and incurving. *Both valves* convex.

This small species, first named and figured, though not described, by Professor Phillips, is with difficulty distinguished from young specimens of *Camarophoria Schlotheimi:* it may be known, however, by having both valves of nearly the same convexity; but the difference may be also recognised by comparing it with full-grown specimens of the latter, which it will be seen could not have had the ribs so prominent when young as they are in correspondingly sized specimens of *C. globulina.*

[1] Perhaps the shell discovered by M. de Verneuil in the Russian carboniferous limestone, and identified with the *Camarophoria Schlotheimi*, may be the same as the species occurring in the carboniferous limestone of Weardale; and the *C. superstes*, the *C. crumena*,—both having a similar marginal outline.

The *Spirifer nucleolus* of Kutorga,[1] found in the Mountain Limestone of Sterlitamak, has a close resemblance to this species.

Camarophoria globulina occurs in the shell Limestone of Humbleton Quarry, Tunstall Hill, Dalton-le-Dale, and Ryhope Field-House Farm; but not so plentifully as the last species: it is also found in the Breccia of Tynemouth.

CAMAROPHORIA MULTIPLICATA, *King*. Plate VII, figs. 26 to 32; Plate VIII, figs. 1 to 7.

TEREBRATULITA LACUNOSA, *Schl.* Von Buch, Ueber Terebrateln, p. 39, 1834.
— — „ Le Cocq., Transl. of Von Buch, Mém. Géol. Soc. de France, p. 152, pl. xiii, fig. 17, 1838.
— — *Zeiten.* Morris, Catalogue, p. 134, 1843.
— — *Schl.* Geinitz, Gæa von Sachsen, p. 96, 1843.
CAMAROPHORIA MULTIPLICATA, *King*. Annals and Mag. of Nat. Hist., vol. xviii, p. 28, 1846.
— — „ Catalogue, p. 7, 1848.
TEREBRATULA HUMBLETONENSIS, *Howse*. Trans. T. N. F. C., vol. i, pp. 252-3, 1848.

Diagnosis.—"Subtriangular, somewhat pointed behind, rounded in front, and a little wider than long. *Dorsal valve* with a round incurved beak, slightly inclined lateral surfaces, and a broad deep flattened mesial furrow. *Ventral valve* with strongly inclined lateral surfaces, and a wide prominent flattened mesial ridge. *Both valves* with numerous small obtuse folds, from five to eight in the furrow, and seven or more on the lateral surfaces."[2]

Camarophoria multiplicata is a larger species than *C. Schlotheimi*, attaining sometimes thrice the size of the latter: it is in general more finely and numerously ribbed: in other respects both species have a striking resemblance to each other; so that many might easily fall into the error of considering one to be an adult form of the other. Comparing, however, full grown specimens of *C. Schlotheimi* with those of corresponding size (young) of *C. multiplicata*, the difference between them will be readily recognised; inasmuch as the latter has a decidedly more compressed form, and its median sinus is only slightly produced (vide Pl. VII, fig. 32). Although stated in the diagnosis to be subtriangular, as represented in Pl. VII, fig. 28, many specimens are found with a subpentagonal outline (vide Pl. VII, fig. 26), and therefore so far simulating *C. Schlotheimi*. Some specimens have the anterior prolongation of the perforate valve falling so rapidly below the sides, or, in other words, projecting so little in advance of them as to make the shell appear much wider than long. (Compare specimens represented in Pl. VIII, figs. 1, 2.)

[1] Verhandlungen der Kaiserlich-Russischen Mineralogischen Gesellschaft zu St. Petersburg. (Jahr 1842, Feb. 5, fig. 7.)

[2] King, Catalogue, p. 7.

Camarophoria multiplicata is a very local species, occurring chiefly at Humbleton Quarry, in the Shell-limestone, where it is not very common. I have found a few specimens in the same formation at Dalton-le-Dale. It does not appear to have been discovered anywhere in the Permian rocks of Germany (unless at Ilmenau, vide Gæa von Sachsen, p. 96) or Russia.

Family Spiriferidæ, *King*, 1846.

Delthyridæ (*partim*), *Phillips*, 1841.

Diagnosis.—"The oral arms very largely developed, and supported the whole of their length by a thin, shelly (?), or cartilaginous (?), spirally twisted plate." (Gray.)[1]

Mr. J. Sowerby, in 1815, was the first to separate the shells belonging to this family from the *Terebratulæ* under the name of *Spirifer*. The institution of *Trigonotreta* by Kœnig was the next step. Fischer de Waldheim shortly afterwards proposed the genus *Choristites*. Dalman, in 1827, followed in the same track by forming *Cyrtia*, *Atrypa*, and *Delthyris*. Professor Phillips, in 1841, provisionally proposed the genus *Cleiothyris*. M'Coy, in 1844, instituted the genera *Athyris*, *Brachythyris*, *Martinia*, *Reticularia*, and *Actinoconchus*. And more recently M. A. d'Orbigny has indicated *Spiriferina*, *Spirigerina*, and *Spirigera*. It will shortly be seen that most of these genera are synonymous.

The double spiral apophysary system, found in all the genera of this family, constitutes its principal distinctive character. This view was first published, I believe, by myself in 1846, when stating that "the spiral form of the labial processes, their immobility, and their spirally folded supports, are characters which eminently distinguish *Spiriferidæ* from every other palliobranchiate family."[2]

Previously to the publication of the researches of Professor M'Coy,[3] extremely vague ideas were entertained as to the use of the spiral appendages; but, in accordance with the views of this author, all palæontologists are now of opinion that they formed the supports of the labial appendages of the Mollusk. Mr. T. Davidson has also contributed to throw some important light on these structures, as existing in the Jurassic *Spiriferidæ*;[4] and from his late communications to me, I have been put in possession of the important fact, that the two crura of the spirals in the fossils last noticed are connected with each other in the centre of the shell.[5] It will readily occur to the reader that the homologues of these crura (i. e. the crura of the loop) in *Terebratulidæ* are projecting and free (vide Pl. XX, figs. 11 and 12 *E*). Had the spirals themselves been thus conjoined, as is the case with the loop in *Terebratula* and

[1] Annals and Mag. of Nat. Hist., 2d series, vol. ii, p. 437.

[2] Idem, vol. xviii, p. 32.

[3] Vide Synopsis of the Carboniferous Fossils of Ireland, pp. 127-8.

[4] Vide London Geological Journal, vol. i, pp. 110-11, pl. xviii, figs. 1, 2, 3.

[5] Figures illustrating this character will be published by Mr. T. Davidson, in his Monograph of Oolitic and Liassic Brachiopoda, which he is preparing for the Palæontographical Society.

Strigocephalus, the validity of Mr. Gray's fundamental classification, which I have adopted, would have been materially prejudiced. Whether the junction of the spirals, by means of their crura, is a character general to the present family, or peculiar to one or more of its subdivisions, I am not prepared to say; I entertain an idea, however, that it will be found to prevail to a much larger extent than we are at present aware of.[1]

Another important character of the spirals elucidated through the researches of Mr. Davidson, is the spine-like processes with which they are armed in certain Jurassic species.[2] Something similar has evidently characterised the spirals of *Cleiothyris pectinifera;* as all the examples I have seen of these appendages, in this species, are pectinated throughout their entire length, as exhibited in fig. 10, Pl. X. Mr. Davidson states, that Professor Owen "thinks they are calcareous excrescences destined, perhaps, to support the cilia."[3] This is extremely probable, considering how very elongated the cilia (= cirri, Forbes) are in *Terebratula caput-serpentis*;[4] but without entertaining an opinion adverse to the view just noticed, I cannot but make the suggestion, from the rigid and enduring nature of the brachial cirri in certain *Terebratulæ*, that the spine-like processes on the spirals may be the cirri themselves fossilized.

As regard the dental and other internal plates of *Spiriferidæ*, there evidently prevail some important modifications. Professor M'Coy,[5] Mr. Davidson's,[6] and my own observations have made known, that between the dental plates of certain Spiriferidæ there is an additional plate,[7] which I feel confident is absent or considerably modified in several others, as *Trigonotreta alata* and *T. undulata*. I have elsewhere termed this structure the *ventral median plate*, and considered it to be a muscular fulcrum (vide ante, pp. 68, 70). The dental plates appear never to be absent, though they exist under various degrees of development in different species: in *Trigonotreta Mosquensis* they are large and very much elongated, almost reaching to the front of the shell; but in *T. alata* they are little more than rudimentary; whereas in *T. cyrtæna* and *T. rostrata*, Zeiten, they are intermediate in size: they are generally attached to the inside of the valve; but in *Spirifer heteroclytus* they are cemented to the lower part of the sides of the median plate, forming an acute arch-shaped process similar to that of *Camarophoria*

[1] Mr. J. de C. Sowerby's figure of the spirals of *Cleiothyris pectinifera* (Min. Conch., pl. 616) represents the crural processes closely approximated: perhaps they are conjoined? I regret that none of my specimens throw any light on this important question.

[2] Vide London Geological Journal, vol. i, p. 111.

[3] Loc. cit.

[4] Vide Forbes and Hanley's British Mollusca, vol. ii, p. 355, pl. U, fig. 1.

[5] Vide Synopsis of the Characters of the Carboniferous Fossils of Ireland, p. 127, fig. 14 *c*, 1844.

[6] Vide London Geological Journal, pl. xviii figs. 2, 4.

[7] Vide Ann. and Mag. of Nat. Hist., vol. xviii, p. 86, 1846. "In *Spirifer cristatus*, *S. Walcotti*, *S. rostratus*, Zeiten, *Martinia imbricata*, &c., this plate, which is large, is situated between, and independent of, the condyle plates." (Loc. cit.)

and *Pentamerus*, and certain Orthises.[1] The socket-plates appear to be in general only slightly developed.

The fissure in *Spiriferidæ* possesses a variable character, being closed by the deltidium in the typical genus; also in certain species of *Trigonotreta* (*T. rostrata* and *T. speciosa*); but it is well known to be open in others. It appears to be closed, when the shell is young, in *Trigonotreta cyrtæna*, and afterwards to become open:[2] on the contrary, in *Trigonotreta undulata* it is open when young, and closed when old.

Spiriferidæ are not generally foraminated: two or three genera are characteristically so, and another only thus partially. In *Spirifer* the foramen passes through the deltidium:[3] in *Retzia* it is complete, and situated at or near the point of the umbone, as in *Terebratula:* while in *Atrypa* (*reticularis*) the same part is similarly foraminated; but only in certain varieties.

The present family differs remarkably from its equivalent and associated groups in rarely exhibiting traces of the vascular system; as the only specimen I have seen displaying them is the one represented in fig. 6 *c*, Pl. IX.

The histology of *Spiriferidæ* offers certain modified characters, which, however, are not of such a nature as is generally supposed. Dr. Carpenter has noticed "perforations very well marked in *Spirifer Walcotti* of the Lias, while they are absent in *Spirifer cuspidatus*, and another mountain-limestone species, and in a species from the Devonian formation of Hudson's Bay."[4] These perforations or punctures have been long known to me, as occurring in certain Permian species; and they have been recently noticed by Dr. de Koninck, who says, "in the genus *Spirifer* several species are known to have the shell perforated, as in certain *Terebratulæ:* these species constitute the genus *Spiriferina* of M. d'Orbigny: the *Spirifer cristatus*, Schl., is in this case: this species I have found among the fossils of M. Roberts;[5] and as none of the perforated Spirifers have yet been found in the carboniferous rocks, we are warranted in concluding that the Palæozoic fossil beds of Spitzbergen belong to the Permian epoch.[6]

But unfortunately for Dr. Carpenter's observation, and Dr. de Koninck's[7] con-

[1] Vide Ann. and Mag. of Nat. Hist., vol. xviii, p. 86, 1846.

[2] This character of the fissure is supported by some unpublished figures of *Trigonotreta cyrtæna* executed in lithograph by Mr. T. Davidson.

[3] In *Spirifer heteroclytus* the deltidium is convex or ridge-like on its inferior half, and concave or furrowed on its upper half: the foramen is situated at the base of the furrow, and passes behind the ridge.

[4] Report of the Fourteenth Meeting of the British Association, p. 18, 1845. Dr. Carpenter states that Mr. Morris had noticed the like difference in other *Spiriferidæ*.

[5] M. Roberts's fossils were collected at Spitzbergen, among which, according to Dr. de Koninck, are *Trigonotreta undulata* and *Strophalosia Cancrini*.

[6] Vide Bulletin de la Soc. Géol. de France, 2^{me} série, t. vi, Seance June 2, 1849.

[7] In some specimens of a carboniferous *Trigonotreta* collected in Belgium, and given me by Mr. T. Davidson, the punctures are as visible as in *T. cristata*. I believe the specimens referred to have been identified by Dr. de Koninck with the last species; but they are certainly distinct.

clusion, I have seen punctures in species of every genus of *Spiriferidæ*, so that I am led to conclude a punctated structure characterised the entire family.[1] The only difference prevailing as regards the punctures, is in their size: in *Trigonotreta Walcotti* they are large; in *T. undulata* they are extremely small; and in *Spirifer heteroclytus* they are intermediate in size.

The proximate affinities of *Spiriferidæ* have not as yet been satisfactorily determined; their spiral labial appendages associate them with *Hypothyridæ;* but to which genus of this family they are immediately related, is far from being sufficiently clear. *Isorhynchus*, concluding from the form of some of its species, offers the nearest approach to certain Silurian Trigonotretas, notably the *T. Marklini* (*Spirifer*, id.) of De Verneuil.

Spiriferidæ were very abundant during the primary period; but at its close, particularly in the Permian division, they appear to have decreased considerably as regards numerical amount of species, though not in the same respect in genera; since four or more groups of this kind, viz., *Trigonotreta*, *Cleiothyris*, *Martinia*, and probably *Spirifer*,[2] were then in existence. During the secondary period only two genera, represented by the Trias *Trigonotreta fragilis*, including the Jurassic species, and a *Martinia* (vide *postea*) are known to have been living.

Our next step will be to notice the various genera included in the present family as given in the Synoptical Table.

Genus *Spirifer*, J. Sowerby, 1815 (= *Cyrtia*, Dalman, 1827).

This genus is typified by the *Anomites cuspidatus* of Martin—a remarkably inequivalved shell; with an elevated area; an upright pedicleiferous umbone; and having, according to M. Deshayes, the fissure closed in all its extent with a deltidium furnished towards its apex with an oval-shaped foramen.[3]

[1] The punctures are best seen by candle-light, with a Stanhope lens. In looking for punctures, *Trigonotreta Walcotti* should be examined first: in the split laminæ of this species the punctures are seen intersecting the capillary fibres, both of which are large compared with what they are in those species in which they are generally considered to be absent.

[2] From the description which Count Keyserling gives of his *Spirifer Schrenki* (vide Reise in das Petchora-Land, p. 234) found in the Permian limestone of Petchora, I am disposed to conclude that it is a true Spirifer.

[3] "Posée sur sa valve supérieure cette coquille a la forme d'une pyramide triangulaire dont la plus grande surface, la seule qui soit plane, est formée par le crochet tout-à-fait droit de la grande valve; cette surface est traversée dans toute sa hauteur par une gouttière triangulaire; si la matière dure de la couche qui la remplit ordinairement a été enlevée, on trouve cette gouttière fermée dans presque toute son étendue, et offrant, vers le sommet, un trou ovalaire, de sorte que cette coquille, malgré l'étrangeté de sa forme, a en effet les caractères des Térébratules." (Animaux sans Vertèbres, 2me Ed., vol. vii, p. 368, 1836.)

Now as the typical species (*Anomites exporrectus*, Wahlenb.) of Dalman's *Cyrtia* agrees with the type of Sowerby's *Spirifer* in form, and in being possessed of a foraminated deltidium (vide ante, p. 124),[1] I am led to assume that both these genera are one and the same; and as the latter name has the priority, I have been led to adopt it in preference to the one proposed by Dalman. This enables me to retain for another group of *Spiriferidæ* a name which many conchologists have considered as a cancelled synonym.

Genus *Trigonotreta*, Kœnig.[2]

Spirifer, *Auct.*
Choristites, *Fischer de Waldheim*, 1825.
Delthyris, *Dalman*, 1827.
Brachythyris, *M'Coy*, 1844.
Spiriferina, *A. d'Orbigny*, 1848.

Diagnosis.—"Testa inæquivalvis, plana aut lobata; valvarum altera superne producta in rostrum externe convexum, interne planum, perforatum, subtriangulare; cardo infra foramen, plerumque linearis, strictus." (Kœnig.)[3]

This genus differs from *Spirifer* in having generally incurved umbones, and a non-foraminated deltidium.

The present section of *Spiriferidæ* has been divided by various parties into two or more genera, as *Choristites*, *Brachythyris* (which are the exact equivalents of *Trigonotreta*), *Delthyris*, and *Spiriferina* (apparently the counterparts of each other). I have for some time past entertained the idea that the two groups thus indicated had each a generic value,—that the *Spiriferidæ*, with large punctures, such as *Trigonotreta Walcotti*, are generically distinct from those which have hitherto been considered as non-punctated:[4] but having arrived at the conclusion that all *Spiriferidæ* have a punctured structure, I have been compelled to abandon this idea: further, the presumed generic distinction appeared to be supported by the median plate, situated between the dental plates, being associated with the punctured structure, as in *T. Walcotti* and *T. cristata*; but the distinction, as founded on this association, is evidently fallacious, since a median plate

[1] Dr. Carpenter states that *Spirifer cuspidatus* is a non-punctated shell, which I suspect is an oversight. The punctures are very distinct in *Spirifer heteroclytus*. I have not had an opportunity of examining a specimen of *Spirifer exporrectus*.

[2] I do not know the date of *Trigonotreta*: it is assumed to have been published prior to 1825, the year in which Fischer de Waldheim described his genus *Choristites*; since it was published in the first part (Centuria Prima) of the 'Icones,' which it is reasonable to suppose appeared before the second, which, according to De Koninck (who notices this part in consequence of its containing a description of *Productus Hoppi*), was published in 1825. (Vide Mon. du Genr. Productus, pp. 80, 267.)

[3] Icones Fossilium Sectiles, p. 3.

[4] I entertained this view when my Synoptical Table went to press—this will explain the recognition therein of *Delthyris*.

is present in *Trigonotreta cyrtæna*,[1] and *T. attenuata*,[2] which, from their punctures being so small as to be with difficulty distinguished, would doubtlessly be placed among the non-punctated *Spiriferidæ*.

After a careful consideration of the present subject, I am led to believe that it will be the most advantageous plan to group all those *Spiriferidæ* in *Trigonotreta* having an area, regardless of its width; the valves ribbed or striated; and the large valve furnished with dental plates, and occasionally a median plate, irrespective of their size.

Choristites Mosquensis, Waldh., and *Spirifer undulatus*, J. de C. Sow., according to this view, are generically inseparable; as the long dental plates of the first are merely enlargements of their rudimentary homologues in the last: *Spirifer princeps*, M'Coy, and *Brachythyris planicostata*, M'Coy, are also referable to one and the same genus; the one having simply a greater lateral development than the other: while *Spirifer Walcotti*, and *Delthyris cyrtæna*,[3] are equally unseverable; because the large median plate of the former is more developed than its homologue of the latter.

The foregoing remarks will explain my reasons for declining to adopt, at least for the present, M. d'Orbigny's *Spiriferina*. I cannot but express my doubt of their being any structural difference between it and *Trigonotreta*: they appear to be separated merely by differences in the development of their respective structures, which it is evident have little or no value in a generic point of view.

Trigonotreta cristata, *Schlotheim*. Plate VIII, figs. 9, 10, 11, 12, 13, 14.

(?) Ostracites crista pulli, *Schl.* Leonhard's Taschenbuch, vol. vii, p. 76, 1813.
Terebratulites cristatus, *Schl.* Akad. Münch., vol. vi, p. 28, pl. i, figs. 3 *a*, *b*, *c*, 1816.
— — ,, Petrefactenkunde, p. 265, 1820.
— — ,, Boué, Edin. Phil. Journ., vol. xii, p. 144, 1825.
(?) — pecten ,, Boué, Loc. cit.
Terebratula cristata ,, De la Beche, Geol. Man., 1st ed., p. 384, 1831; Germ. Transl. p. 459, 1832; and 3d Eng. ed., p. 573, 1833.
Spirifer octoplicatus, *J. de C. Sow.* Von Buch, Ueber Delthyris, p. 39, 1834.
Terebratula cristata, *Schl.* Phillips, Encyc. Met., vol. iv, p. 617, 1834.
Spirifer cristatus ,, Quenstedt, Wiegmann's Archiv, p. 79, 1835.
Terebratula cristata ,, Thomson, Outlines of Min. Geol., &c., vol. ii, p. 324, 1836.
Spirifer cristatus (*partim*), *Schl.* Le Cocq., Mém. Géol. Soc. de France, t. iv, p. 185 (excluding the figures).[4]

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[1] The median plate is displayed in an unpublished figure of the internal structure of this species by Mr. T. Davidson.

[2] Vide M'Coy's Synopsis of the Characters of the Carboniferous Fossils of Ireland, p. 127, fig. 14 *c*.

[3] I have seen species with the median plate of a more rudimentary form than in *Delthyris cyrtæna*; but I have not been able to ascertain their specific name.

[4] The figures appear to be copies of J. Sowerby's *Spirifer octoplicatus* (Min. Conch., pl. 562, figs. 2, 3).

	Spirifer cristatus, *Schl.*		„	Geinitz, Gæa von Sachsen, p. 97, 1843.
	—	—	„	Morris, Catalogue, p. 128, 1843.
	—	—	„	De Verneuil, Bull. Soc. Géol. de France, 2me série, t. i, p. 28, 1844.
	—	—	„	Geol. Russ., vol. i, p. 221, 1845.
	—	—	„	Tennant, Brit. Fossils, p. 88, 1847.
	—	—	„	King, Catalogue, p. 8, 1848.
	—	—	„	Howse, Trans. T. N. F. C., vol. i, p. 254, 1848.
	—	—	„	Geinitz, Versteinerungen, p. 12, pl. v, fig. 10, 1848.
(?)	—	—	„	De Koninck, Bull. Soc. Géol. de France, 2me série, t. vi, Seance June 2, 1849.

Diagnosis.—Semi-elliptical marginally: with generally eight prominent angular ribs. *Surface* with prominent lines of growth. *Punctures* large, giving the valves a coarsely granulated appearance. *Large valve* half as high as it is wide, slightly rounded: *umbone* slightly incurving: *area* moderately high: *fissure* moderately large, and open: *median plate* deep, and extending from the umbonal point to the centre of the valve. *Small valve* slightly elevated, and somewhat flat: *median rib* twice the size of those immediately adjoining.

Trigonotreta cristata closely resembles one or more so-called species found in the Carboniferous and other formations, particularly the *T. octoplicata* of J. Sowerby. Having examined in Mr. J. de C. Sowerby's collection the originals (from Derbyshire) of the figures in the 'Mineral Conchology,' the only difference I could perceive is, that they are wider than any examples which have occurred to me of the present species.[1] Specimens bearing the name of *Spirifera insculpta*, in the Gilbertsonian collection of the British Museum, appear to be undistinguishable from *Trigonotreta cristata*. The Jurassic fossil which Zeiten has identified with the *T. octoplicata*, is another closely analogous species.

Its large punctures give this species a remarkable appearance, particularly in casts, which are often crowded with short truncated spines standing erect on the surfaces to which they adhere; the same being casts of tubular punctures, which passed uninterruptedly through the entire thickness of the valves from the inner to the outer surface. The punctures, and their casts, are represented, highly magnified, in figs. 13, 14, Pl. VIII.

Trigonotreta cristata was first recorded as a British species by Quenstedt, who notices its occurring at Humbleton. I have found it at Tunstall Hill, Hylton North Farm, and Tynemouth Cliff; but in none of these localities is it a common fossil, especially in the last three. Schlotheim, its earliest discoverer, noticed it at Glücksbrunn; and Geinitz gives the following additional German localities, Könitz, Pössneck, Altenstein, Schwaara, and Röpsen. If De Koninck be correct in the identification, it may be stated as also occurring in Spitzbergen. It does not appear to have been found in Russia.

[1] Mr. J. de C. Sowerby's specimens have punctures like those of *Trigonotreta cristata*.

TRIGONOTRETA MULTIPLICATA, *J. de C. Sowerby*. Plate VIII, figs. 15, 16, 17, 18.

SPIRIFER MULTIPLICATUS, *J. de C. Sow.*			Sedgwick, Trans. Geol. Soc., 2d series, vol. iii, p. 119, 1829.
—	—	,,	De la Beche, Geol. Man., 1st ed., p. 384, 1831; Germ. Transl. p. 459, 1832; 3d Eng. ed., p. 573, 1833.
—	—	,,	Phillips, Encyc. Met., vol. iv, p. 617, 1834.
—	—	,,	Morris, Catalogue, p. 129, 1843.
—	—	,,	De Verneuil, Bull. Soc. Géol. de France, 2^{me} série, t. i, p. 28, 1844.
—	—	,,	Geol. Russ., vol. i, p. 221, 1845.
—	—	,,	Tennant, Strat. List., p. 88, 1847.
—	—	,,	King, Catalogue, p. 8, 1848.
—	—	,,	Howse, Trans. T. N. F. C., vol. i, p. 254, 1848.

Diagnosis.—Semi-oblong marginally; about half an inch in width, and three eighths in length; with generally ten rather prominent obtusely-rounded ribs. *Surface* with prominent lines of growth. *Punctures* large, giving the valves a coarsely granulated appearance. *Large valve* nearly half as wide as it is high; somewhat rounded: *umbone* moderately incurving: *area* one third of its width in height: *fissure* rather large and open: *median plate* elevated, and extending to nearly the centre of the valve. *Small valve* moderately rounded: *median rib* depressed; and nearly thrice the width of those immediately adjoining it.

Trigonotreta multiplicata, so designated in order to preserve a specific name given by Mr. Sowerby to an undescribed fossil of the present genus, noticed in Professor Sedgwick's paper, closely resembles the last species, as will be seen by the foregoing diagnosis; but differs from it in having the valves more rounded; the ribs smaller, obtusely rounded, and more numerous; the umbones a little more gibbous; and the median rib in the flat valve wider and flattened.

The present species has only occurred to me in the Shell-limestone at Tunstall, where it is not common; and in a fragment of Magnesian Limestone brought up by a fisherman's line from the sea-bottom, about thirty miles from land, off the coast of Northumberland.

TRIGONOTRETA JONESIANA,[1] *King*. Plate VIII, fig. 19.

SPIRIFER MULTIPLICATUS, *J. de C. Sow.* (*partim*). King, Catalogue, p. 8, 1848.

Diagnosis.—Subglobular in form; about three eighths of an inch in width, and a little less in length; with from eight to ten rather small evenly-rounded ribs. *Surface* with regular and rather distant lines of growth, and finely granulo-punctated. *Large*

[1] Named in compliment to Mr. T. Rupert Jones, who has in the kindest manner described the Microzoa of the present Monograph.

valve two thirds of its width in height; rounded: *umbone* incurved: *area* nearly as high as it is wide: *fissure* moderately large and open: *median plate* extending to nearly the centre of the valve: *dental plates* rudimentary. *Small valve* moderately convex: *median rib* broad, and evenly rounded.

This species, which until now (January 1850) I have considered as inseparable from *Trigonotreta multiplicata*,[1] has a striking resemblance to young specimens of the Silurian *Spirifer strigoplocus* of De Verneuil (vide Geol. Russ., vol. ii, pl. iv, fig. 2 *a*, *b*, *c*, *d*), the most obvious difference between them being in the sharpness of the areal angle of the large valve, and in the umbone of the same valve projecting further behind the hinge-line, in the latter species. From *Trigonotreta multiplicata* the present shell differs in several important points: it is less in width; has a more prominent umbone; a higher area; the ribs are more evenly rounded, and at a greater distance from each other; the median rib on the small valve is more evenly convex, or its corresponding furrow in the opposite valve more evenly concave; the dental plates also are smaller. De Verneuil's *Spirifer Blasii*, a contemporaneous species, would resemble the present fossil were it divested of the small ribs intervening the large ones.

Trigonotreta Jonesiana occurs rather sparingly at Ryhope Field-House Farm, Dalton-le-Dale, and Tunstall Hill in Shell-limestone.

Trigonotreta alata, *Schlotheim.* Plate IX, figs. 4, 5, 6, 7, 8, 9, 10, 11, 12.

Terebratulites alatus, *Schl.* Leonhard's Taschenbuch, vol. vii, p. 58, pl. ii, figs. 9 *a*, *b* (excluding figs. 1, 2, 3[2]), 1813.
— — ,, Petrefactenkunde, p. 250, 1820.
— — ,, Boué, Edin. Phil. Journ., vol. xii, p. 144, 1825.
Terebratula alata ,, Brongniart, Tab. de Ter., p. 425, 1829.
Spirifer alatus ,, Quenstedt, Wiegmann's Archiv., p. 79, 1835.
— — ,, Geinitz, Gæa von Sachsen, p. 97, 1843.
— — ,, Geinitz, Grundriss, p. 513, pl. xxii, figs. 1-4, 1846.
— convolutus, *Phillips.* King, Catalogue, p. 7, 1848.
— undulatus, *J. de C. Sow.* Geinitz, Versteinerungen, p. 13, pl. v, figs. 1-8, 1848.[3]

Diagnosis.—Somewhat fusiform: bi-areagerous: two inches and a half wide, and an inch long. *Valves* moderately convex: thick at their cardinal region: marked with

[1] This is the reason why no more than one figure has been given of this species. Figure 19, Plate VIII, represents a young specimen twice the natural size.

[2] Schlotheim has represented different species under one specific name in the Taschenbuch, vol. vii, pl. ii: this has given rise to numerous errors: Von Buch correctly refers to fig. 9, but incorrectly to figs. 1 and 3: De Verneuil follows Von Buch; and Geinitz refers only to figs. 1, 2, 3, none of which represents the present species.

[3] It is probable that the names *Spirifer trigonellus* and *S. paradoxus*, given by several authors in their list of Permian fossils, have reference to this species: Von Buch and other German palæontologists have also referred to it under the head of the next species, *Trigonotreta undulatus*.

regular rounded imbricated laminæ of growth, which are crossed with numerous fine striæ: with a wide, moderately deep, median furrow; numerous rounded, occasionally dichotomous ribs on the lateral surfaces, gradually decreasing in size as they approach the sides; and a faint one in the median furrow: occasionally plicated parallel to the cardinal line. *Umbones* rather strongly incurved. *Fissure* open when young, and covered with a laminated deltidium in old specimens. *Dental plates* small, curving, and coalescing.

In my 'Catalogue' this species is identified with Phillips's *Spirifera convoluta;* but having lately examined specimens of the latter shell in the British Museum, I am now satisfied that the identification is erroneous. Both species are obviously closely related to each other; but there are several small ribs in the median furrow in *T. convoluta;* whereas in *T. alata* there is only one thus situated: and the lateral ribs run out from the cardinal region more obliquely in the former than in the latter.

The dental plates in this species have an unusual form, being small, curving and coalescing at their upper part, so as to become arch-shaped, as represented in fig. 12, Pl. IX. The deltidium is also unusual in its structure, as it consists of strong arching lamellæ. Specimens attain a tolerably large size before the deltidium is formed,—a peculiarity which distinguishes this shell from *Trigonotreta speciosa*, an analogous species, in which this structure is completely formed in much younger or smaller specimens. The spiral processes have a close resemblance to those represented by Professor M'Coy (vide Synopsis, p. 127, fig. 15), except that the free or projecting portion of their crura is longer. The crura of the spiral, represented in Pl. IX, fig. 8, are so invested with foreign mineral matter, that it is impossible to say whether they remain separated or become united through curving towards each other, as in the Jurassic Trigonotretas already noticed; appearances, however, do not oppose the latter being the case. The punctures differ widely from those characteristic of the preceding species, in being so small as to be only visible by a high magnifying power.

Trigonotreta alata is not an uncommon species in the shell limestone of Humbleton Hill, and in the compact limestone of Midderidge. It also occurs at Schmerbach, Rœpsen, Merzenberg, Könitz, Pœssneck, Ronneburg, Gera, Seissla, Wöhlsdorf, Ilmenau and Noberg, in Germany.

TRIGONOTRETA UNDULATA, *J. de C. Sowerby.* Pl. IX, figs. 1, 2, 3, 13, 14, 15, 16, 17.

SPIRIFER UNDULATUS, *J. de C. Sow.* Mineral Conchology, vol. vi, p. 119, pl. 562, fig. 1.
— — „ Genera of Shells, Plate of Spirifer, fig. 3.
— — „ Sedgwick, Trans. Geol. Soc. London, 2d series, vol. iii, p. 119, 1829.
— — „ De la Beche, Geol. Man., p. 384, 1831; Germ. Transl. p. 459, 1832; and 3d Eng. ed., p. 572, 1833.

Spirifer undulatus, *J. de C. Sow.*			Phillips, Encyc. Met., vol. iv, p. 617, 1834.
—	—	,,	Von Buch, Ueber Delthyris, p. 37, 1834.
—	—	,,	Thomson, Outlines of Geology, &c., vol. ii, p. 326, 1836.
Terebratula undulata		,,	Deshayes, Lamarck's Animaux sans Vertèbres, 2d ed., vol. vii, p. 371, 1836.
Spirifer undulatus		,,	Le Cocq., Transl. of Von Buch, Mém. Soc. Géol. de France, t. iv, p. 183, pl. vii, fig. 6.
—	—	,,	Morris, Catalogue, p. 131, 1843.
—	—	,,	Brown, Fossil Conchology, p. 110, pl. 50, figs. 27, 28, 1843.
—	—	,,	Lyell, Elements of Geology, p. 416, fig. 241, 1838.
—	—	,,	De Verneuil, Bull, Soc. Géol. de France, 2me série, vol. i, p. 28, 1844.
—	—	,,	Geol. Russ. vol. i, p. 222, 1845.
(?) —	hystericus (?)	,,	Idem, vol. ii, p. 173, pl. vi, fig. 12, 1845.
(?) —	(Espèce indéterminée), *De Vern.* Loc. cit., fig. 13.		
—	undulatus, *J. de C. Sow.* Tennant, Strat. List., p. 89, 1847.		
—	alatus, *Schl.* King, Catalogue, p. 7, 1848.		
—	undulatus, *J. de C. Sow.* Howse, Trans. T. N. F. C., vol. i, p. 254, 1848.		

Diagnosis.—"Transversely elongated, very convex, with pointed extremities, radiated transversely, and deeply striated; front elevated, with a rounded sinus; radii obtuse, about 16 on each side the central elevation; beaks a little removed; area flat, narrow." (J. de C. Sow.)[1]

This species has often been confounded with *Trigonotreta alata*, both of which simulate each other; but *T. undulata* differs from *T. alata* in being more tumid at the umbones, more produced in front, and a narrower shell: the last difference is well displayed in young specimens of both species, as represented in figs. 10 and 16, Pl. IX.[2] Both species agree in other respects.

Mr. J. de C. Sowerby having kindly favoured me with an examination of the original specimen of this species, figured in the 'Mineral Conchology,' I embrace the present opportunity of drawing up from the same the following description, which, with Mr. Sowerby's diagnosis, and the figures herein given (vide Pl. IX, figs. 1, 2, 3), will enable the reader to form a tolerably correct idea of its characters. Semi-elliptical in marginal outline: bi-areagerous: very inequivalved: two inches in width, and an inch and an eighth in length, that is, from the umbone to the termination of the sinus-prolongation in the large valve. *Large valve* moderately convex: *median sinus* broad; rather deep; with a faint median rib: *lateral surfaces* each with fourteen or more cord-like ribs, about half of which have resulted from dichotomy on the umbonal region: *umbone* much incurved, and projecting considerably behind the hinge line:

[1] Mineral Conchology, vol. vi, p. 119.

[2] Since the plates were engraved, I have collected young specimens half the size of those in the figures referred to, showing the same differences.

area equal to the width of the shell; slowly decreasing in height from the centre to the terminations, which are bluntly tapering: *surface* covered with regular imbricated lamellæ of growth, which, in passing over the ribs, appear as if undulating: *incremental lamellæ* very finely striated in the cross direction, which results from the microscopic capillary-like fibres constituting the substance of the shell. *Small valve* two thirds the length of the large valve, and similarly ribbed: *median elevation* moderately prominent: *area* low: *umbone* slightly prominent: *punctures* extremely small.

I strongly suspect that the fossil which de Verneuil has doubtingly identified with the *Terebratulites hystericus* of Schlotheim, and the "espèce indéterminée" of the same author are referrible to the present species.

Trigonotreta undulata (as well as the last species) is prettily ornamented with regular imbricated laminæ of growth crossed with fine striæ, which, when examined with a magnifier, are seen to resemble capillary fibres regularly arranged in parallel series, as represented in fig. 17, Pl. IX.

This species occurs in the compact limestone at Midderidge (Sowerby); in the shell limestone at Tunstall Hill, and Humbleton Quarry; and in the Breccia at Tynemouth Cliff. It has not yet been noticed in Germany, owing probably to its being confounded with *Trigonotreta alata*. The "espèce indéterminée, and the so-called '*Spirifer hystericus*?' are from the Permian rocks of Russia; the former from Bielebi (government of Orenbourg), and the latter from Kirilof.

TRIGONOTRETA PERMIANA, *King*. Plate IX, figs. 18, 19, 20, 21, 22, 23, 24.

SPIRIFER PERMIANUS, *King*. Catalogue, pp. 7-8, 1848.

Diagnosis.—Margin "semi-elliptical. Twice as wide as long. *Lateral surfaces* with four or more sharpish, rather distant ribs. *Mesial furrow or ridge* not much larger than the adjoining folds. *Beak* erect"[1] in casts; but gibbous in testiferous specimens. *Valves* marked with regular lamellæ of growth, crossed with hair-like striæ.

This well-marked species, which rarely exceeds an inch in width, and half an inch in length, differs from *Trigonotreta undulata* in having a narrower median furrow, or elevation, and only half the number of folds, which are broader and more angulated than those of the latter: the valves are not so tumid, and the lateral extremities are rounded instead of pointed. These distinctive characters are equally well displayed on young as on old specimens. The valves are marked with lamellæ of growth and punctures agreeing with those of the last two species.

I have seen in Mr. T. Davidson's collection a Belgian fossil, which, if I mistake not, Dr. de Koninck has identified with *Trigonotreta cristata*, Schl.: it has a closer resemblance, however, to the present species; but it differs in having large punctures.

[1] King, Catalogue, pp. 7-8.

Trigonotreta Permiana is of rare occurrence in the shell limestone at Humbleton Quarry and Tunstall Hill,[1] the only localities known.

Genus *Martinia*, M'Coy, 1844.

Spirifer, *Auct.*
Reticularia (included), *M'Coy.*

Diagnosis.—"Hinge-line shorter than the width of the shell; dorsal edges of the cardinal area obtusely rounded; surface smooth; spiral appendages small." (M'Coy.[2])

Type, *Spirifer decora*, Phillips.

"The short-hinged Spirifers were distinguished long ago by that excellent artist and friend of Mineral Conchology, Mr. W. Martin, and placed by him in a separate division from the long-hinged, ribbed species; they were afterwards confounded together by the late Mr. Sowerby under the general name of *Spirifer*, in the 'Mineral Conchology;' they were then separated again by Professor Phillips, in his admirable 'Geology of Yorkshire,' and form the fourth division of his genus Spirifer; and more recently Von Buch, in his Memoir on the genus *Delthyris*, forms of them his second division of the Spiriferidæ, but hitherto no author has named, or fully characterised, this most natural genus."[3]

This genus seems to unite *Trigonotreta* with *Atrypa* or *Athyris*. It has the area and fissure of the former, combined with the outline of the latter; but *Atrypa* and *Athyris* also differ from *Martinia* in being foraminated.

The histology of the present genus is somewhat variable. In the typical forms the shell is fibrous and finely punctated; in certain of those forming M'Coy's genus *Reticularia* the punctures are large, and the fibres appear to be coarse; and in one of the species hereafter noticed, but in which punctures have not yet been discovered, the fibres appear to have a very coarse character.

Martinia Clannyana,[4] *King*. Plate X, figs. 11, 12, 13.

Martinia Clannyana, *King*. Catalogue, p. 8, 1848.

Diagnosis.—"A minute species; as wide as long; nearly smooth: *front* slightly emarginate: *deltidial valve* very convex, with a slight mesial furrow: *ventral valve* nearly flat: *area* equilateral: *deltidium* a little narrower than the area." (King.)[5]

[1] Through an oversight, the locality "Tynemouth" was given in my 'Catalogue' instead of Tunstall Hill.

[2] Synopsis of the Characters of the Carboniferous Fossils of Ireland, p. 139.

[3] Loc. cit.

[4] Named after the late Dr. William Reid Clanny, who published in the 'Annals of Philosophy,' vol. vi, a paper entitled 'An Account of the Sunderland Limestone Formation,' and containing the earliest notice of a fish found in the English Permian rocks.

[5] Catalogue, p. 8.

This species closely resembles the Devonian *Atrypa unguicula* of J. de C. Sowerby, as figured by Professor Phillips, in his 'Palæozoic Fossils of Cornwall' (pl. xxxviii, fig. 119). None of my specimens exceed three sixteenths of an inch in width.

Only a few specimens of *Martinia Clannyana* have occurred to me in one locality—Ryhope Field-House Farm—in the Shell-limestone.

MARTINIA WINCHIANA,[1] *King*. Plate X, figs. 14, 15, 16, 17.

MARTINIA WINCHIANA, *King*. Catalogue, p. 8, 1848.

Diagnosis.—Marginal outline nearly circular. Half an inch in diameter. *Hinge* three quarters of the width of the valves. *Large valve* moderately convex: *umbone* elevated, and slightly incurved: *fissure* open, triangular: *dental plates* rudimentary. *Small valve* slightly convex: *socket-plates* large, and slightly divaricating.

"This, which is a small species, resembles *Martinia Clannyana* in form, but both valves are crowded with short, hair-like, declined, radiating spines."[2]

I have transcribed the above from my 'Catalogue,' but without vouching for the concluding statement. I have only seen casts and impressions of this species, and in all the latter there are numerous radiating, fibre-like markings, which I formerly considered to be the remains of spines; and it was in accordance with this view that the restoration of the shell, represented in Plate X, fig. 17, has been given. A recent examination of these impressions leaves the question an open one in my mind; though I still lean to my original view, qualified, however, with the supposition, that the fibre-like markings may be the remains of a coarse fibrous tissue forming the substance of the valves, similar to that already noticed occurring in Camarophorias.

The St. Kassian fossil represented in Count Münster's 'Beiträge,' and identified with *Spirifer rostratus*, appears to have a close resemblance to the present species.

Martinia Winchiana is of very rare occurrence. I have only collected a few specimens in one locality (Whitley); where they occurred in the lowest beds.

Following the various genera of *Spiriferidæ* according to order of affinity, the one requiring notice in the next place is a genus instituted by the author of the 'Synopsis of the Characters of the Carboniferous Fossils of Ireland.'

[1] Named after Mr. Nathaniel J. Winch, the author of 'Observations on the Geology of Northumberland and Durham,' in the 'Transactions of the London Geological Society,' 1st series, vol. iv; and some other valuable papers illustrating the geology of the north of England.

[2] King, Catalogue, p. 8.

Genus *Athyris*[1] (*partim*), M'Coy, 1844.

Atrypa (*partim*), *Dalman.*
Spirigera, *A. d'Orbigny,* 1848.

Typified with Von Buch's *Terebratula concentrica,*[2] this group is characterised with an internal structure widely removing it from its immediately associated genera. In my paper on the 'Palliobranchiata,' it was shown that the apophysary system of the last-named shell possesses a peculiar character.[3] The dental plates are not immediately attached to the inner surface of the large valve, as in *Cleiothyris,* but to a singular structure resembling, when detached, a shoe-lifter, and cemented by its lateral margins to the medio-longitudinal region of the valve, with the narrow end fitting into the point of the umbone, and the opposite end terminating over the centre of the shell. The small valve is furnished with an elevated medio-longitudinal plate, supporting the crural base. Mr. T. Davidson has more recently published some figures representing the interior of *Atrypa tumida,* Dalman,[4] which I am led to believe belongs to the present genus. In examining my own specimens of this species, from Norway, with the view of ascertaining if it possessed an apophysary system resembling that of *Athyris concentrica,* I have discovered in the small valve precisely the same largely-developed medio-longitudinal plate supporting the crural base as in the latter: the shoe-lifter-like process, however, only exists under a rudimentary condition. But in a large specimen of an allied shell (if not a variety) found at Malvern, and evidently the same as the one identified by Mr. T. Davidson with Dalman's species, the last structure is more decidedly developed. The convex body between the dental plates in one of Mr. Davidson's figures, already noticed, appears to be the structure alluded to. A shoe-lifter-like process is to be seen in the *Terebratula Herculea* of M. Barrande as well developed as in *Athyris concentrica.* I forego making any further remarks on the internal structure of this genus; because it is understood that M. Bouchard Chantereaux is in possession of some novel and excellent materials which he is preparing for publication.

Should *Atrypa prunum,* Dalman, hereafter prove to be a species of *Athyris,* which I confidently anticipate, this genus will be placed in immediate proximity to *Martinia;* since the species just named, by its form and rudimentary area, is closely related to *Martinia pachyrhynchus,* De Verneuil; while in another point of view *Athyris* is without doubt proximately connected with the following.

[1] The name *Athyris,* like *Atrypa,* is a misnomer; as few, if any, of the species are without a foramen.

[2] I suspect that *Terebratula concentrica,* Von Buch, is the only species of the number placed by M'Coy in *Athyris,* belonging to the genus: all the others appear to belong to *Cleiothyris.*

[3] Vide Annals and Magazine of Natural History, vol. xviii, p. 86, 1846.

[4] Vide Bull. de la Soc. Géol. de France, 2me série, t. v, pl. iii, fig. 26.

Genus *Atrypa*, Dalman,[1] 1827.

This group is here limited to species resembling its type, the *Anomia reticularis* of Linnæus, in being generally ribbed or striated, in having the large or foraminiferous valve with flat or concave lateral regions and a broad median sinus, and in being furnished with a slightly-developed apophysary system—the spirals excepted. Certain varieties of *Atrypa reticularis*—those with an area, and a projecting umbone foraminated at the apex, and bounded inferiorly by a deltidium (vide ante, p. 72)—in pointing out the affinities of the genus, conduct us at once to another group of shells, now for the first time elevated to a co-ordinate rank.

Genus *Retzia*,[2] King.

Diagnosis.—A Spiriferidia; in general oval longitudinally; ribbed or striated; with large punctures.[3] *Large valve* foraminated at or near the apex of the umbone; with a triangular area, and a closed fissure.

Type *Terebratula Adrieni*, De Verneuil.

This interesting genus, well distinguished by the above characters from other *Spiriferidæ*, embraces some pretty species, such as *Retzia Baylii* (*Terebratula id.*, Davidson), *R. Bouchardii* (*T. id.*, Dav.), *R. Oliviani* (*T. id.*, De Vern.), and *R. Salteri* (*T. id.*, Dav.) *Terebratula ferita*, and some other spirigerous Terebratulæform species, I am strongly disposed to regard as belonging to the same genus. *Retzia*, by its form, holds the same relation to the family to which it belongs as *Eudesia* does to *Terebratulidæ*. It appears to be a purely palæozoic genus, being only found as yet in the Silurian, Devonian, and Carboniferous rocks. Professor Phillips and Dr. de Koninck have described two or more carboniferous species.

From *Retzia* we pass on to a group of shells, the last to be noticed in connexion with the present family.

Genus *Cleiothyris*,[4] Phillips, 1841.

Diagnosis.—Generally lenticular in form; minutely punctured; with variously-characterised projecting laminæ of growth. *Spirals* pectinated. *Dental plates* large

[1] Synonyms: (?) *Hipparionyx*, Vanuxem (vide Sharpe, 'Quarterly Journal of the Geological Society,' vol. iv, part i, p. 180); *Spirigerina*, A. d'Orbigny, 1848.

[2] This genus is dedicated to Retzius, who published a 'Dissertation' on *Terebratula*, in 1788.

[3] Mr. Morris was the first who noticed punctures in species (*Tereb. Adrieni*, and *T. ferita*) of this genus. (Vide Quarterly Journal of the Geological Society, vol. ii, part i, p. 387.)

[4] From "κλειω, claudo; θυρα, janua," Phillips. The name is synonymous with *Actinoconchus*, M'Coy (1844), and J. de C. Sowerby's "Section 1" of Dalman's *Atrypa* (Min. Conch. vol. vii, p. 11 and 14); also in part with *Athyris*, M'Coy. Professor Phillips in his 'Palæozoic Fossils,' p. 55, proposed the name *Cleiothyris* as a substitute for *Atrypa*, Dalman; but as there are several cogent objections to the use of substitute names, even if they be more correct or more euphonious than the original, the present one cannot

and separated. *Crural base* perforated. *Foramen* situated at the point of the umbone, and open inferiorly by the fissure.[1]

Type *Atrypa pectinifera*, J. de C. Sowerby.

Cleiothyris, it will be seen by the above diagnosis, differs in several respects from *Atrypa*, the genus in which its type has hitherto been placed; and from *Athyris*, with which it is more closely allied, in having the dental plates immediately attached to the inner surface of the large valve, and in being without a medio-longitudinal plate in the opposite valve. Probably it also differs from *Athyris* in the valves being generally furnished with variously-characterised projecting lamellæ of growth (as in *Cleiothyris planosulcata*, Phill., *C. pectinifera*, J. de C. Sow., and *C. expansa*, Phill.); in the spirals being pectinated (vide Pl. X, fig. 10); and in having a perforate crural base[2] (vide Pl. X, figs. 8, 9). Looking at the figure which Mr. T. Davidson has published of the spiral apophysary system of the small valve of a species apparently belonging to *Athyris*,[3] there appears to be a wide difference between this genus and *Cleiothyris* in their respective spiral crura, which, in the latter, are similar to those of *Trigonotreta*; whereas, in the former, they appear to be conjoined for a considerable extent, so as to resemble a long wire-like process, forked at its termination, near the centre of the shell, each fork appearing as if it passed into, or became connected with, the spiral to which it is directed.

The projecting lamellæ of growth are evidently the same as those characterising certain Discinas. The minute punctures noticed in the diagnosis are displayed in some of my specimens of *Cleiothyris ambigua* (*Spirifer id.*, J. Sow.) Respecting the use of the perforation in the crural base, I am unable to offer any opinion. Has it any relation to the wire-like process above noticed?

I am not aware of the occurrence of species of this genus in any other than deposits belonging to the Carboniferous and Permian systems.

CLEIOTHYRIS PECTINIFERA, *J. de C. Sowerby.* Plate X, figs. 1-10.

"SPHEROIDAL" TEREBRATULA, *J. de C. Sowerby.*		Trans. Geol. Soc., 2d series, vol. iii, p. 119, 1829.
ATRYPA PECTINIFERA	„	Min. Conch., vol. vii, p. 14, pl. 616, (all the figures,) 1841.

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be used in such a sense: further, as a group of shells hitherto placed in *Atrypa* requires a name, I have made free to adopt Professor Phillips's rather than propose one myself, a step which has one recommendation in its favour, that of using up a synonym.

[1] The following is the diagnosis given by Professor Phillips: "Cardinal area obsolete, beak incurved over a minute perforation, which is often obtect, or merely serves to receive the beak of the smaller valve." (Palæozoic Fossils, p. 55.)

[2] *Cleiothyris ambigua* (*Spirifer id.*, J. Sow.) has a perforated crural base.

[3] Vide Bull. de la Soc. Géol. de France, 2^{me} série, t. v, pl. iii, fig. 26.

	Atrypa pectinifera, *J. de C. Sowerby.*			Morris, Catalogue, p. 120, 1843.
	Terebratula pectinifera, *J. de C. Sowerby.*			De Verneuil, Bull. Soc. Géol. de France, 2me série, t. i, p. 27, 1844.
	—	—	„	Geol. Rus., vol. i, p. 222, 1845.
(?)	—	—	„	Op. cit., vol. ii, p. 57, pl. viii, fig. 12 *a*, *b*.
(?)	—	concentrica, var., *Von Buch.*		Op. cit., vol. ii, pp. 54-5, pl. viii, fig. 11.
	—	pectinifera, *J. de C. Sow.*		Keyserling, Petschora-Land, p. 238, 1846.
	Atrypa	—	„	Tennant, Strat. List, p. 88, 1847.
	—	—	„	King, Catalogue, p. 8, 1848.
	—	—	„	Howse, Trans. T. N. F. C., vol. i, p. 253, 1848.
	—	—	„	Geinitz, Versteinerungen, pp. 11-12, pl. iv, figs. 37-40, 1848.

Diagnosis.—"Transversely obovate; surface covered with concentric ciliated fringes."[1]

This species, which has the valves "moderately and equally convex" (Sowerby), has a striking resemblance to *Cleiothyris Roissyi* (a larger shell) in its singular pectinated or spinose lamellæ of growth; but it differs therefrom in having the median sinus only slightly indicated. It has also some resemblance to *Spirifera expansa*, Phillips, and some other carboniferous species. One of Mr. Sowerby's figures correctly represents the spines projecting from, and forming part of, the incremental lamellæ: they are in some instances nearly a quarter of an inch in length. If the Russian Permian shell, which M. de Verneuil considers a variety of *Terebratula concentrica*, Von Buch, be not a variety of *Cleiothyris Roissyi* (which is also a Permian shell, in Russia), I should have very little hesitation in referring it to the present species; although none of my specimens display the sinus so strongly marked as it does.

Cleiothyris pectinifera appears to have been a more variable shell in Germany than in England, as all my British specimens have a remarkably striking similarity to each other; whereas those occurring in Germany, judging of the figures given by Dr. Geinitz, are extremely variable in form,—some being wide and flattened (vide Pl. IV, fig. 37, *a*, *b*, *c*), approximating in these respects to *Cleiothyris Roissyi*; while others are much narrower (vide fig. 38, *a*, *b*, *c*) than any that have occurred to me in England.

The internal structure, which I consider diagnostic of the genus, is pretty correctly represented in Pl. X, figs. 8 and 9; and so is the pectinated character of the spiral processes in fig. 10 of the same plate. I may also refer to one of Mr. Sowerby's figures, which, besides displaying the peculiarity last noticed, exhibits the homologues of the free portions of the crura of the loop in *Terebratulidæ* similarly pectinated. The apparent union of these parts, in the figure under notice, has already been alluded to. (Vide *ante*, pp. 122-3.)

[1] J. de C. Sowerby, 'Mineral Conchology.' vol. vii, p. 14.

Cleiothyris pectinifera, as British, is only known to occur in the shell-limestone of Humbleton Quarry, where it is not common; and in the Breccia of Tynemouth Cliff, where it is extremely scarce: the testiferous specimen represented in Pl. X, figs. 1, 2, 3, 4, is the only one I have procured in the latter place. It is also a scarce fossil in Germany; since Dr. Geinitz records its occurrence in only two localities, Milbitz and Corbusen in the under Zechstein. The Russian shells included in the synonymy from de Verneuil, were found in the Permian marls of Kirilof, Tioplova west of Arzamas, and Nikefur in Bielebei, Orenbourg. Count Keyserling records its occurrence in Permian limestone on the Wol near Kischerma, and on the Wym near Seregof, in Petschora-Land.

Sub-class ANCYLOPODA, J. E. Gray.

Diagnosis.—"The oral arms recurved."[1]

This division is distinguished from its co-ordinate, *Helictopoda*, in having the labial appendages or oral arms recurvedly folded, and not spirally twisted as in the latter,—a difference which is in like manner participated by the apophyses of these organs.

It will be recollected that certain groups of *Helictopoda* have their labial appendages either entirely unsupported, or only slightly sustained by an apophysary system; for example, *Sarcicobrachia* and *Hypothyridæ;*—probably the same may be predicated of the Ancylopodous groups *Rhynchoridæ* and *Argiopidæ*.

Mr. Gray has divided the present sub-class into two orders, *Ancylobrachia* and *Cryptobrachia;* but for the reasons elsewhere given (vide ante, pp. 81-2.), it has been deemed advisable to merge both into one, distinguishing it by the first appellation.

Order Ancylobrachia, Gray.

Diagnosis.—"The oral arms" in general "affixed to calcareous plates, forming hoops attached to the hinge-margin of the ventral valve (dorsal, *nobis*), and prominent in its cavity."[2]

Having placed in the present order the families *Argiopidæ* and *Rhynchoridæ*, the

[1] Mr. Gray adds: "and affixed to fixed appendages on the disc of the ventral valve. Shell minutely and closely perforated." (Vide Annals and Mag. of Nat. Hist., 2d series, vol. ii, p. 435.) In the next page the following diagnosis is added: "The oral arms not extensile, or only at the tip; on fixed shelly supports, or in grooves in the under or ventral valve; the mantle is adherent to the shell, the substance of the shell being pierced with numerous minute perforations, which are pervaded by the processes of the mantle." I have considered it best to leave out the foregoing in the text, as some Anchylopods appear to be without shelly supports: as to the shell being perforated, this appears to be a character general in the Palliobranchs.

[2] Annals and Magazine of Natural History, 2d series, vol. ii, p. 435.

former with a rudimentary apophysary system in the form of isolated plates, and the latter apparently without any, I have made free to make a trifling addition to Mr. Gray's diagnosis, so as to qualify it for the reception of what appear to be a few exceptional cases.

I purpose, in the next place, adverting to the families herein included in the present order, briefly noticing those, and their constituent genera, which are not Permian for the sake of comparing them with the Permian groups.

Family Strigocephalidæ, King.

This group is typified with the genus *Strigocephalus*, and differs from its equivalents chiefly in certain of its cardinal characters,—notably its foraminated deltidium, which resembles that of *Orthisina;* and in its enormously developed ventral median plate, cardinal boss or muscular fulcrum, and (sub-marginal, anneliform) loop.[1] It seems to be confined to the Devonian system.

Family Rhynchoridæ, King.

This group I propose typifying with the genus *Rhynchora*. It differs from *Terebratulidæ* in generally possessing an area, and a sub-apical foramen; and perhaps in its normal members being without a loop. The absence of the last character is to a certain extent supported by a figure of *Rhynchora spathulata*, Wahlenb. in the 'Lethea Svecica' (Pl. XXII, fig. 9 *b*), and by another in the 'Lethæa Geognostica' (Pl. XXX, fig. 5 *d*) of the interior of *Delthyridæa pectiniformis* (*Tereb. id.*, J. Sow.), both of which appear to be as much divested of an apophysary system as an *Orthis*, or any other Sarcicobrachial palliobranch. The same negative character appears to be confirmed by the interior of a *Rhynchora costata*, Wahlenberg, with which, including several other Swedish fossils, I have been kindly supplied by M. Clason, of Fuhrdal, in Delacarlia.

Besides the typical genus (typified with *Rhynchora costata*, Wahl.), the present family embraces *Delthyridæa*,[2] M'Coy (the type of which appears to be the *Terebratula pectiniformis*), and the one next to be noticed.

[1] For a description of the internal structure of *Strigocephalus*, vide ante, pp. 70-72.

[2] Kœnig founded the genus *Trigonosemus* on a shell named *Trigonosemus elegans* (Icon. Foss., Sect., p. 3, pl. vi, fig. 73). Taking into consideration the external characters of *Terebratula lyra*, Sow., which is also included in the genus, *Trigonosemus* appears to be synonymous with *Delthyridæa;* but as I am totally unacquainted with the type just named, it is impossible for me to give a positive opinion on the subject. It would be well if the original specimen of *Trigonosemus elegans* were fully described.

Genus *Ismenia*,[1] King.

Diagnosis.—Uni-areagerous: wider than long: plicated: semicircular in front, and angulated behind. *Hinge line* slightly inclined on each side of its centre. *Area*, both halves oblique to the hinge-margin, and to each other. *Umbone* projecting behind the hinge-line, and truncated with the *foramen*, which is large, and closed inferiorly by the deltidium. *Punctures* moderate in size.

Type *Terebratulites pectunculus*, Schlotheim.

This genus has much the appearance of *Delthyridæa;* but it differs principally in having the area and the hinge-line not straight, and the foramen not below the point of the umbone. *Ismenia* posteriorly has a decided approach to certain *Terebratulidæ;* whereas *Delthyridæa* strongly simulates *Spiriferidæ*. It appears to be a connecting link between *Rhynchoridæ* and *Terebratulidæ*.

There appear to be other genera of the present family belonging to the secondary rocks.

Family Magasidæ (*partim*), A. d'Orbigny.

The type of this group is the genus *Magas*, J. Sowerby, which with *Bouchardia*,[2] Davidson, are the only genera it appears to contain. I have some doubt as to either of them possessing characters sufficiently distinctive to warrant their removal from *Terebratulidæ*.

Family Argiopidæ, King.

This group, or rather its type *Argiope*, Deslongchamps (=*Megathyris*, A. d'Orbigny), is included by Mr. Gray in the next family; but both its external and internal characters are obviously opposed to the association.

Family Thecidæidæ (*partim*), Gray.

The completely distinctive character of this group is too generally admitted to require any other than a passing allusion to it. Probably some modifications in *Thecidæidæ* and *Argiopidæ*, as far as they bear on their associate groups, will be required when the animal belonging to their respective types is made known.

[1] Named after Ismēne, a daughter of Œdipus and Jocasta. (Vide Lempriere's Bibliotheca Classica.)

[2] Vide Bull. de la Soc. Géol. de France, Dec. 1849. Certain characters of the type of *Bouchardia* (viz., *Terebratula rosea*, Humph.) were briefly noticed by myself in the Annals and Magazine of Natural History, vol. xviii, pp. 34, 38, 1846.

Family TEREBRATULIDÆ (*partim, Les Térébratules*), Cuvier.

CYCLOTHYRIDÆ (*partim*), *Phillips*, 1841.
EPITHYRIDÆ, *Morris*, 1846.

Diagnosis.—Generally with an apically foraminated umbone, and a recurvedly folded loop.

It is proposed to limit this family to those genera which have generally the foramen at the apex of the umbone, and the apophysary system in the form of a loop; and it is further proposed to recognise certain modifications of the latter structure as diagnostic of generic divisions.

All the known genera have their valves characterised with punctures, which have been very faithfully and elaborately detailed by Dr. Carpenter, as they occur in a few species.[1] The punctures vary in size: in some (*Megerlia, Waldheimia*, &c.), they may readily be seen with an ordinary magnifier; but in others (*Epithyris, Eudesia*, &c.), they cannot be detected so readily without a Stanhope lens.

Genus *Terebratula* (*partim*), Lhwyd, 1698.

TEREBRATULA (sp. *cranium*, &c.), *Müller*, 1766.
ANOMIA (*partim*), *Linnæus*.
TEREBRATULA (*partim*), *Retzius* (1788), *Bruguière, Lamarck*.
GRYPHUS (sp. *vitrea*), *Megerle*, 1811.
2ME SOUS-SECT. 1RE DIV. BRACHIOP., *Eudes-Deslongchamps*, 1837.
TEREBRATULA (typified with sp. *vitrea*, after Lam.), *King*, 1846.

Diagnosis.—The typical Terebratulidia; with a *loop* more or less anneliform; confined to the posterior portion of the shell; and attached to the crural base. *Labial appendages* partly attached to, and projecting considerably in front of, the loop.

Müller, one of the earliest adopters of *Terebratula*, having included in it species possessing the characters given in the above diagnosis, and Lamarck having headed the genus with the *Anomia vitrea* of Gmelin, we are prevented, according to the rule which has been adhered to in the present work, recognising the name *Gryphus*, subsequently proposed by Megerle, for the present group. I took precisely the same view in my paper on 'Palliobranchiata'; and accordingly typified the genus *Terebratula* with the species *Anomia vitrea*.

I am not aware of any species of the present genus occurring in older rocks than the secondaries.

[1] Report of the Fourteenth Meeting of the British Association, 1845.

Genus *Pygope*, Link, 1830.

The apophysary system of this group resembles that of the last genus; but a separation appears to be warranted by some presumed differences in their labial appendages. From the singular prolongation or separation of the lateral halves, and the undeveloped character of the medio-longitudinal region of the shell of *Pygope diphya*, I am led to suspect that the labial appendages of its inhabitant were exceedingly long, and separated from each other nearly at their base; in which case the lateral halves of the shell would each be occupied with the free and projecting portions of these organs; and there would consequently be no reciprocal connexion between them except in the buccal region—a character unparalleled in any other known Palliobranchiate genus, with perhaps the exception of *Dicælosia*.

Pygope is only known to occur in the latest secondary deposits.

Genus *Eudesia*,[1] King.

Terebratulæ, *Auct.*
2me Subd., 1re Div. Brachiop., *Eudes-Deslongchamps*, 1837.

Diagnosis.—A plaited Terebratulidia. *Marginal outline* more or less oblong longitudinally. *Beak* projecting; truncated with a large *foramen*, which is bounded inferiorly by a *deltidium*. *Punctures* moderate in size.

Type *Terebratula orbicularis*, J. Sowerby.

Eudesia is proposed with some hesitation; because it bears so close a resemblance to the striated division of *Terebratula*, represented by *T. caput-serpentis*, which is *suspected* to be the type of A. d'Orbigny's *Terebratulina*, that it is doubtful whether it is a distinct genus.

Genus *Terebratella*, A. d'Orbigny, 1848.

Not being acquainted with the diagnosis of this group according to the views of its author, I make free to characterise it as having a loop projecting considerably into the cavity of the shell, and attached posteriorly to the crural base, and anteriorly to the medio-longitudinal plate.

Type *Terebratula Chilensis*.

[1] This genus is dedicated to M. Eudes-Deslongchamps.

Genus *Megerlia*,[1] King.

Diagnosis.—A transversely-oblong, uni-areagerous Terebratulidia. *Umbone* very slightly projecting. *Fissure* or *foramen* large, emarginate, and situated in the centre of the area. *Cardinal muscular fulcrum* excavated. *Loop* somewhat quadrate; confined to the posterior half of the shell; attached posteriorly to the crural base, and anteriorly to the medio-longitudinal plate. *Inner surface of valves* radiately pimpled. *Punctures* large.

Type *Anomia truncata*, Gmelin.

The species just noticed is included by M. d'Orbigny in *Terebratella;* but as it manifestly possesses a generic character of its own, I have been induced to consider it as typifying a distinct (and in appearance a widely separated) genus. Perhaps the proper position of *Megerlia* is in the family *Rhynchoridæ*.

Genus *Waldheimia*,[2] King.

Diagnosis.—A smooth or widely plicated, longitudinally-oblong Terebratulidia. *Umbone* projecting; and truncated with a rather large *foramen*, which is bounded inferiorly by a bisected *deltidium*. *Loop* forming a nearly complete ellipsis; projecting considerably into the cavity of the shell; deeply folded back on itself so as to nearly reach its crura; and attached simply to the crural base. *Labial appendages* attached to the loop throughout their entire length. *Punctures* large.

Type *Terebratula Australis*, Quoy et Gaymard.

Waldheimia differs from *Terebratula* in the form of the loop, and the character of the labial appendages,[3] both of which structures, in the former, are intimately connected with each other, the loop supporting the labial appendages throughout their entire length; whereas in the latter, these organs project considerably beyond a small anneliform apophysis, which mainly serves as a visceral support. The loop in the typical species of *Waldheimia*, owing to its being so deeply recurved, is in the form of a double ellipsis; and it projects about two thirds of the length of the shell.

Several Jurassic *Terebratulidæ* appear to belong to the present genus.

[1] This genus is dedicated to the author of a paper entitled 'Entwurf eines neuen Systems der Schaalthiere von J. K. Megerle v. Muhlfeld,' in the Freunde zu Berlin, &c., 1811.

[2] This genus is dedicated to His Excellency Fischer de Waldheim, to whom we are much indebted for several valuable contributions on the Palæontology of Russia.

[3] There is evidently a wide difference between *Waldheimia* and *Terebratula* in their labial appendages; but I am not prepared at present to enter on the subject.

Genus *Epithyris*, Phillips,[1] 1844.

Terebratula, *Auct.*
1re Sous-Sect., 1re Div. Brachiop. (*? partim*), *Eudes-Deslongchamps*, 1837.

Diagnosis.—A longitudinally-oblong Terebratulidia; furnished with prominent *dental plates*, and a transversely semi-elliptical, moderately recurved *loop*.

Type *Terebratulites elongatus*, Schlotheim.

Professor Phillips, in his 'Palæozoic Fossils,' proposed the name *Epithyris* as a substitute for that of *Terebratula;* and at the same time applied it to a generic group, which he characterised as having "the beak truncate, perforate." The name has hitherto been considered in the light of a synonym; but I propose applying it to one of the subdivisions of the old genus *Terebratula*, represented by the Permian species above named, and distinguished from all its co-ordinates, hitherto noticed, by having its rostral cavity furnished with prominent dental plates, and its apophysary system somewhat resembling the half of a transversely bisected ellipsis. *Waldheimia* is most intimately related to *Epithyris;* but the difference will be at once evident by a reference to the figures representing their respective internal structures (vide Pl. VI, fig. 45; Pl. XX, fig. 11). In *Waldheimia* the loop is elliptical, deeply recurved, and projecting about two thirds of the length of the shell; but in *Epithyris* it is semi-elliptical, moderately recurved, and projecting about one third of the length of the shell.

The differences just noticed clearly indicate a distinction in the animal; because, from the short and slightly recurved character of the loop of *Epithyris*, it must be concluded that the labial appendages have been either unusually short and attached throughout their entire length, or long and free towards their base. But in either case a difference is involved, of sufficient importance to constitute a generic distinction between *Epithyris* and *Waldheimia;* inasmuch as in the latter the labial appendages, although long, are nevertheless attached throughout their entire length. In the view taken, *Epithyris* also becomes related to *Terebratula;* but the greater distance of the cross piece of the loop from its crura, in the former, indicates that the visceral mass has been more voluminous than it is in the latter. The difference in this respect is still greater between *Epithyris* and *Waldheimia*, in consequence of the cross piece of the latter being brought nearly in contact with the crura (vide Pl. XX, fig. 11). On the whole, it would appear that the present genus, in its loop and labial appendages, is intermediate between *Terebratula* and *Waldheimia*.

Epithyris appears to have been the earliest created genus of *Terebratulidæ;* as species occur in the Devonian rocks: remains are also present in deposits belonging to later periods; but none are known to me as occurring in more recent rocks than the Jurassic.

[1] Palæozoic Fossils, p. 55.

The two species next to be described are the only certain Permian forms with which the palæontologist is acquainted.

EPITHYRIS ELONGATA, *Schlotheim*. Plate VI, figs. 30-45.

TEREBRATULITES ELONGATUS, *Schl.* Akad. Münch., vol. vi, p. 27, pl. vii, figs. 7 *a, b, c*, 8, 9, 1816.
— COMPLANATUS ,, Op. cit., pl. vii, figs. 13, 14 *a, b, c*.
— LATUS ,, Op. cit., pl. vii, fig. 12.
— ELONGATUS ,, Petrefactenkunde, p. 277, 1820.
— — ,, Boué, Edin. Phil. Journal, vol. xii, p. 144, 1825.
— COMMUNIS, Var. *b*, LATUS, *Schl.* Loc. cit.
(?) TEREBRATULA, N. S., *Phillips*, Phil. Mag., N. S., vol. iv, p. 401, 1828.
FLAT TEREBRATULA, *J. de C. Sow.* Trans. Geol. Soc. Lond., 2d series, vol. iii, p. 119, 1829.
TEREBRATULA ELONGATA, *Schl.* Brongn., Tab. de Terr., p. 425, 1829.
— — ,, De la Beche, Geol. Man., p. 384, 1831; Germ. Transl., p. 459, 1832; 3d Eng. ed., p. 573, 1833.
— COMPLANATA, *Schl.* Op. cit.
(?) — INTERMEDIA ,, Op. cit.
— ELONGATA ,, Phillips, Encyc. Met., vol. iv, p. 617, 1834.
— COMPLANATA ,, Op. cit.
(?) — INTERMEDIA ,, Op. cit.
— ELONGATA ,, Von Buch, Ueber Terebrateln, p. 100, 1834.
— — ,, Quenstedt, Wiegmann's Archiv, 1835.
— — ,, Le Cocq, Transl. Von Buch, Mém. Soc. Géol. de France, vol. iii, p. 211, pl. xix, fig. 10, 1838.
(?) — QUALENII, *Fischer*. Bull. des Nat. de Moscou, p. 466, 1842.
(?) — — ,, Kutorga, Verh. der Min. gesellsch. St. Petersburg, p. 26, pl. vi, fig. 2, 1842.
(?) — PLICA ,, Kutorga, Ib., pl. v, fig. 11.
— ELONGATA, *Schl.* Morris, Catalogue, p. 133, 1843.
— — ,, Geinitz, Gæa von Sachsen, p. 97, 1843.
— — ,, De Verneuil, Bull. Soc. Géol. de France, 2^{me} série, vol. i, p. 26, 1844.
— — ,, Geol. Russ., vol. i, p. 222; vol. ii, pp. 66-9, pl. ix, fig. 9 *a, b, c, d*, 1845.
— — ,, Keyserling, Petschora-land, p. 238, 1846.
— CASSIDEA, *Geinitz*. Grundriss, p. 507, 1846.
— ELONGATA, *Schl.* Ibid., p. 508.
— — ,, Tennant, Strat. List, p. 88, 1847.
— — ,, King, Catalogue, p. 7, 1848.
— — ,, Howse, Trans. T. N. F. C., vol. i, p. 251, 1848.
— — ,, Geinitz, Versteiner., p. 11, pl. iv, fig. 27 *a, b, c, d*, 1848.

Diagnosis.—Smooth to the eye; but microscopically granulated, through being crowded with moderate-sized punctures: in general three quarters of an inch in

length, and nearly five eighths in width: widest generally a little in front of its medio-transverse line: somewhat obtusely rounded in front, and tapering behind: rather compressed: posterior margins rounded: anterior margins sharp. *Large valve* depressed in its anterior half, and slightly rounded posteriorly; with a broad, somewhat flattened, shallow *sinus* in the medio-longitudinal region: *umbone* moderately prominent and incurved: *foramen* moderate in size; truncating the point of the umbone; and bounded inferiorly by the apex of the deltidium. *Small valve* obtusely ridged in its medio-longitudinal region; with the lateral surfaces sloping rapidly to the margins.

This is such a remarkably variable species, that it is difficult to draw up more than an approximate diagnosis of it; and for the same reason I have been compelled to represent more specimens than would have been necessary under ordinary circumstances. Figures 30 to 43, inclusive, Plate VI, represent the principal varieties.

Figs. 30, 32, and 37 (different specimens) are assumed to represent the typical or normal forms.

Figs. 31, 39 (one specimen), and 35 (young), a narrow variety.

Figs. 33, 36, and 43 (one specimen), a compressed wide variety, with a broad and very shallow median sinus. Sp., *Terebratulites latus*, Schl.

Fig. 42, a variety, with a very deep median sinus.

Fig. 34, a variety, with a narrow umbonal region, and a rounded anterior half.

Schlotheim considered some of the above varieties as species. I have no decided objection to this view; but I feel myself utterly unable to separate one form from another, they merge so imperceptibly into each other. It has therefore been deemed the best plan to unite them under only one of Schlotheim's names,—the one generally received.

Terebratula plica, Kutorga, found in the Mountain Limestone of Sterlitamak is considered by De Verneuil to be a variety of the present species: they undoubtedly resemble each other in some respects; but I have not yet seen any specimens of the latter with the lateral marginal line so strongly curved as in the specimen represented by Kutorga, in the 'Verh. der Min. gesellsch. St. Petersb.,' 1842, pl. v, fig. 11 *c*. The specimen which I have partially represented in Pl. VI, fig. 42, offers an approach to it; and Dr. Geinitz has figured a specimen offering a still nearer approximation (Versteinerungen, pl. iv, fig. 27 *c*): so that I am somewhat inclined to De Verneuil's opinion. If Fischer's *Terebratula Qualenii* be correctly represented by Kutorga in the work cited, I have considerable doubt of its being the same as *Epithyris elongata*, having never seen any specimens so narrow in the umbonal region: there is an approximation to it, however, in the specimen represented in Pl. VI, fig. 34.

Some specimens appear to be identical with De Verneuil's *Terebratula fusiformis*, a Carboniferous species. Since my plates were engraved, I have procured specimens at Tunstall Hill apparently undistinguishable from the one represented in the 'Geology of Russia,' vol. ii, pl. ix, fig. 8 *a*, *b*. Specimens from the Carboniferous Limestone of

Bolland, often identified with *Terebratula hastata*, are in no respect different from the ordinary form of the present species. Certain varieties of *Epithyris elongata* have much the aspect of the Muschelkalk *Terebratula angusta*,[1] Schl., found in the Mine de Frédéric à Tarnowitz, in Silesia; but no specimens have occurred to me with "un sillon étroit" on the ventral or small valve, which the latter is said to possess.[2]

The punctures of *Epithyris elongata*, highly magnified in Pl. VI, fig. 44, are much smaller than in many Terebratulidias, for example, *Waldheimia*, etc.: they give a finely granulated surface to the shell when examined by a Stanhope lens; and in some places they display a strong tendency to fall into a linear arrangement.

The loop occupies the posterior third of the shell, and is folded back on itself to a distance equalling half its length.[3]

The average size of this species is about three quarters of an inch long and nearly five eighths wide; but occasionally specimens occur fully double this size.

Epithyris elongata is a very common fossil at Tunstall Hill, Humbleton Quarry, Dalton-le-Dale, Ryhope Field-House Farm, in Shell-limestone. It is of much rarer occurrence in the contemporaneous rock at Hylton North-Farm, Castle-Eden-Dene, and at the north end of Black-Hall Rocks; also in the Breccia at Tynemouth. It is suspected to have been found at Ferry Bridge by Professor Phillips; and I have little doubt of its occurring in the Mountain Limestone of Bolland. Von Buch states it to be found at Meiningen and Schmerbach; and Dr. Geinitz records its occurrence in the under Zechstein and Zechstein-dolomite of Corbusen, and a number of other German localities. De Verneuil states that "in Russia this species is only found in the Permian system, in which it is very abundant" (Geol. Russ., vol. ii, pp. 67, 68): it occurs at Nikefur, Santagulova, Orenbourg, Jemangulova, Mount Tchelpan, Itschalki, and at the embouchure of the Sakmara. Count Keyserling has discovered it "in the Permian Limestone on the Wytschegda near Ustnem and Myldina" (vide Reise in das Petschora-Land, im Jahre 1843, p. 238).

EPITHYRIS SUFFLATA, *Schlotheim.* Plate VII, figs. 1 to 9.

	TEREBRATULITES SUFFLATUS, *Schl.*		„	Akad. Münch., vol. vi, p. 27, pl. vii, figs. 10, 11, 1816.
	—	—	„	Petrefactenkunde, p. 277, 1820.
	—	—	„	Boué, Edin. Phil. Journal, vol. xii, p. 144, 1825.
(?)	—	INFLATA	„	Brong., Tab. de Terr., p. 425, 1829.

[1] Vide Von Buch, Ueber Terebrateln.

[2] The so-called *Terebratula elongata*, represented in Count Münster's Beiträge, Heft iv, pl. vi, fig. 14, and found in the (?) Triassic marls of St. Kassian, appears to be another species: its beak is too much produced compared with the Permian fossils.

[3] The sketch of the loop in Plate VI, fig. 45, does not represent this structure so faithfully as could be wished: it is rather too wide in front, and the recurved portion ought to have been carried a little further back.

	Terebratulites	sufflata, *Schl.*	Von Buch, Ueber Terebrateln, p. 102, 1834.
(?)	—	,,	Phillips, Encyc. Met., vol. iv, pl. iii, fig. 4, 1834.
(?)	—	inflata ,,	Op. cit., p. 617.
	—	sufflata ,,	Quenstedt, Wiegmann's Archiv, 1835.
	—	— ,,	Le Cocq., Transl. Von Buch, Mém. Soc. Géol. de France, t. iii, pp. 213-14, pl. xix, fig. 12 *bis*, 1838.
	—	— ,,	Morris, Catalogue, p. 137, 1843.
	—	— ,,	De Verneuil, Bull. Soc. Géol. de France, 2me série, t. i, p. 26, 1844.
	—	— ,,	Geol. Russ., vol. i, p. 222, 1845.
	—	elongata, var. *Schl.*	Op. cit., vol. ii, p. 69, pl. ix, fig. 9 *c*.
	—	sufflata ,,	Tennant, Strat. List, p. 88, 1847.
	—	— ,,	King, Catalogue, p. 7, 1848.
	—	elongata ,,	Geinitz, Versteinerungen, p. 11, pl. iv, fig. 29 *a*, *b*, *c*; fig. 32 *a*, *b*, *c*, &c., 1848.

Diagnosis.—Smooth to the eye; but microscopically granulated through being crowded with minute punctures: in general five eighths of an inch long, and half an inch wide: anterior half widest, and obtusely rounded: posterior half rather tapering: moderately and regularly convex: rounded at the margins of the anterior half: marked with rather prominent lines of growth. *Large valve* with a regularly-formed moderately-sized median furrow: *umbone* prominent and gibbous: *foramen* moderate in size; truncating the point of the umbone; and bounded inferiorly by the apex of the deltidium. *Small valve* regularly rounded.

Epithyris sufflata is not so variable as *E. elongata*: its variation is chiefly limited to the median sinus, which, although well defined in general, is occasionally only slightly indicated, as in the specimen represented in figs. 6 and 9, Pl. VII.

It is smaller and more tumid than the last species; and so obviously distinct from it, that I totally disagree with Geinitz in uniting them. It differs from *Epithyris elongata* in having both valves more regularly rounded; the umbone more gibbous, and prominent; the margins of its anterior half rounded, and not sharp; the small valve not ridged (but rounded) medio-longitudinally; the lines of growth stronger; the median sinus narrower, and more obviously defined; the posterior half not quite so tapering; and the punctures rather smaller.

Epithyris sufflata appears to be identical with a shell found in the mountain-limestone of Bolland, probably hitherto considered a variety of *E. sacculus*—a distinct, though closely allied species. The latter differs from the former principally in having the front decidedly emarginate: both appear to graduate into each other.

Epithyris sufflata is a less common species than *E. elongata*. It occurs at Humbleton Quarry (first noticed by Quenstedt), Tunstall Hill, Ryhope Field-House Farm, Dalton-le-Dale, and Castle-Eden-Dene, in Shell-limestone; and at the north end of Black Hall rocks, in a brecciated form of a probably parallel rock; also at Tynemouth Cliff, in what appears to be a subordinate bed of breccia. The apparently identical shell,

already noticed as occurring at Bolland, induces me to believe that it belongs to the Carboniferous system of this locality. According to Von Buch, it occurs at Meiningen and Schmerbach; and according to Geinitz, (vide 'Versteinerungen,' Erklärung der Tab. iv) in the under Zechstein and Zechstein-dolomite of Corbusen and Könitz, Germany. The shell which De Verneuil has figured with the name *Terebratula elongata* (though with a suspicion that it belongs to the present species, of which I have no doubt), is from the Permian marls of Itschalki, near Arzamas, in Russia. From some figures in Münster's 'Beiträge' (Heft iv, pl. vi, fig. 15 *a*, *b*), one would be tempted to conclude that it occurred in the Trias marls of St. Kassian.

Since my remarks were printed, on "the remarkable valve figured by M. de Verneuil" (vide ante, p. 80), and which I ascertained, before my Synoptical Table in page 81 was printed off, had been elevated to the rank of a genus, under the name of *Davidsonia*, by M. Bouchard Chantereaux, in a Mémoire published in the 'Annales des Sciences Naturelles,' for Aug. 1849, I have been kindly favoured by the author with a copy of the Mémoire, in which I perceive that quite a different view is taken of the use of the "cones" from what is advocated by M. de Verneuil and myself. M. Bouchard considers them as adductor muscular impressions; but, notwithstanding the arguments of my learned friend, I am still in favour of their having been produced by the labial processes.

From a sketch which Mr. Davidson has just sent me, of the interior of *Terebratula pulchella*, which belongs to *Delthyridæa*, I am now satisfied that I was in error in supposing this genus to be without an apophysary system (vide ante, p. 141); as the species cited is furnished with a loop agreeing with that of *Terebratula*. The next question for consideration is—have *Ismenia pectunculus* and *Rhynchora costata* a loop?

Class Lamellibranchiata, Blainville.

Dithyra, *Aristotle.*
Acéphales Testacés, *Cuvier.*
Conchifera, *Lamarck.*
Bivalvia, *Fleming.*

Diagnosis.—"The Lamellibranchiata are bivalve conchiferous Mollusca, which respire by gills in the form of muscular plates of membrane attached to the mantle." (Owen.)[1]

This extensive group of what may be termed ordinary bivalve shells, is divisible into two sections, depending on their valves being attached to each other by one or two adductor muscles.

Order Monomyaria, Lamarck.

Mésomyones, *Latrèille*, 1825.

Diagnosis.—The valves attached to each other by a sub-centrally situated muscle.

The present section, of which the common oyster is a familiar example, contains the following as its Permian representatives.

Family Pectenidæ (*Les Pectinides, partim*), Lamarck.

With the exception of *Anomidæ* and *Ostreidæ*, this family is the lowest in classification of the present class, and widely distinguished from those named in several important particulars; even obviously from the last one, in which it is often placed; as its *superior valve* (the notched one in *Pecten*, the attached one in *Spondylus*) is *inferior* in *Ostreidæ*: it does not appear to be sufficiently known that, in this respect, both *Anomidæ* and *Ostreidæ* differ from all other Monomyarians.

Of the genera included in this family, the two following are all that are known to occur in the Permian rocks of England.

Genus *Pecten*, Müller.

Diagnosis.—"Shell sub-orbicular; beaks approximate; ligament internal, seated in a triangular cavity, a byssus issuing under the ear of the right valve; foot small, pedunculated; mouth with branched tentacula." (Fleming.)[2]

The present genus has existed from the Devonian period to the present time.

[1] Lectures on Comparative Anatomy, vol. i, p. 269.
[2] British Animals, p. 383.

PECTEN PUSILLUS, *Schlotheim*. Plate XIII, figs. 1,[1] 2, 3.

(?) NEW SPECIES OF PECTEN, *Thomson*. Annals of Philosophy, vol. iv, p. 417, 1814.
DISCITES PUSILLUS, *Schl.* Akad. Münch., vol. vi, p. 31, pl. vi, fig. 6 *a*, *b*, *c*, 1816.
PLEURONECTES PUSILLUS, *Schl.* Petrefactenkunde, p. 219, 1820.
— — „ Boué, Edin. Phil. Journ., vol. xii, p. 144, 1825.
PECTEN, (S. N.), *J. de C. Sow.* Trans. Geol. Soc. Lond., 2d series, vol. iii, p. 120, 1829.
(?) PECTEN PRISCUS, *Schl.* Brongniart, Tab. de Ter., p. 423, 1829.
PECTEN, SP. not determined. De la Beche, Geol. Man., p. 385, 1831; Germ. Transl., p. 459, 1832; 3d Eng. ed., p. 573, 1833.
— PUSILLUS, *Schl.* Münster., Goldfuss's Petrefacta, vol. ii, p. 72, pl. xcviii, fig. 8 *a*, *b*, *c*, 1835?
LIMA DISCITES PUSILLA, *Schl.* Quenstedt, Wiegmann's Archiv, vol. ii, p. 81, 1835.
PECTEN — „ Morris, Catalogue, p. 114, 1843.
— PUSILLUS „ Geinitz, Gæa von Sachsen, p. 96, 1843.
— — „ De Verneuil, Bull. Soc. Géol. de France, 2me série, vol. i, p. 34, 1844.
— — „ Geol. Russ., vol. i, p. 225, 1845.
— — „ Tennant, Strat. List, p. 88, 1847.
— — „ King, Catalogue, p. 9, 1848.
— — „ Howse, Trans. T. N. F. C., vol. i, p. 250, 1848.
— — „ Geinitz, Versteinerungen, pp. 10, 11, pl. iv, fig. 22 *a*, *b*, 1848.

Diagnosis.—"Shell ovate orbicular equivalve sub-equilateral, convex, smooth. Ears subrectangular, unequal, the fore part of the right valve in a great degree subplicate." (Goldfuss.[2])

This is a rather tumid, smooth, equivalved, marginally sub-orbicular species, scarcely ever exceeding half an inch in diameter: its byssal notch is rather deep (vide Pl. XIII, fig. 2); its anterior ear is the longest: the sides of its umbones are nearly perpendicular.

Pecten pusillus is rather common in the Shell-limestone of Humbleton Hill; but much rarer in the same formation at Tunstall Hill: it is also rare in the inferior beds at Whitley quarry, and in the breccia at Tynemouth Cliff. A specimen was found in the Doggerbank fragment of Magnesian limestone. Dr. Geinitz records its occurrence in the under Zechstein of Corbusen, and in the Zechstein-dolomite of Glücksbrunn and Liebenstein.[3]

[1] This figure represents the shell as too oblique.

[2] "Testa ovato-orbiculari æquivalvi subæquilaterali convexa lævi, auriculis subrectangulis inæquilallibus, antica valvæ dextræ majori subplicata."

[3] In the list of Pectens given in Professor Sedgwick's paper in Trans. Geol. Soc. London, 2d series, vol. iii, p. 120, it is stated: "To this list Mr. Phillips has added a circular fluted species, two inches and a quarter in diameter;" but no fossil has yet occurred to me agreeing with this description.

Genus *Lima*, Bruguière.

Diagnosis.—"Shell longitudinally oblong, with ears; beak remote; ligament external." (Fleming.)[1]

This genus is not known to have existed previously to the permian period; but since then it has ever continued to be an inhabitant of our globe.

Lima Permiana, *King*. Plate XIII, fig. 4.

Diagnosis.—Half an inch in diameter: smooth: oblique towards the posterior direction: somewhat circular: slightly tumid. *Hinge-line* short. *Umbone* small.

The above diagnosis is taken from a specimen of the left valve, the only one that has occurred to me. At first I took it for a valve of *Pecten pusillus*, to which it has a close resemblance; but its obliquity, and the regular sloping sides of its umbone, prove it to be a totally different shell. I have little doubt of its being a species of *Lima*.

Humbleton Quarry, in the Shell-limestone, is the only locality that has yielded me this species.

Family Aviculidæ (*Les Arondes*), Cuvier, 1800.

Diagnosis.—"Shell often foliated, generally rather thin, nacreous, subæquivalve; hinge without teeth, or furnished with some in a rudimentary state; with an anterior notch for the passage of the byssus." (Sander Rang.)[2]

Genus *Monotis*, Bronn.

Avicula, *Auct.*

Diagnosis.—"Shell subequivalve, unequilateral, subauriculate, depressed, closed, auriculated behind, subrotund before. Ear continuous. Umbones depressed submediate. Margin of the hinge linear, callous, without teeth. Canal bending downward in an outward direction beneath the umbones, closed on the right valve with an entering fold."[3]

The typical genus of *Aviculidæ* has two subcentral muscular impressions in each valve (the posterior or largest belongs to the adductor muscles, and the anterior to one of the posterior divisions of the pedal muscles), a trapezoidal cartilage pit, and a sinus-like byssal opening in the inferior valve. None of the homologous structures are

[1] British Animals, p. 388.

[2] Manuel de l'Histoire, Naturelle des Mollusques, p. 285.

[3] "Testa subæquivalvis, inequilatera, subauricularis, depressa, clausa; postice auriculata antice rotundata. Auricula continua. Umbones depressi-submedii. Margo cardinalis linearis, callosus, edentulus, canali sub-umbone antrorsum vergente, in valva dextra a plica intrante obturato." (Goldfuss, Petrefacta, p. 137.)

thus characterised in the shell next to be noticed, and which is commonly placed in the genus *Avicula*; on the contrary, it has a deep angular byssal notch (vide Pl. XIII, fig. 7 *a*), a sub-triangular cartilage pit, and a single subcentral muscular impression (vide Pl. XIII, fig. 20 *a*),—characters which appear to approximate the genus, claiming it, to *Pectenidæ*. Perhaps the claiming genus is typical of an undescribed family, merging *Pectenidæ* into *Aviculidæ*. This view is somewhat confirmed by the histology which Dr. Carpenter has described of a probably congeneric species, the *Avicula cygnipes*, Phillips, in which "we find no trace of either the prismatic cellular substance or the nacre, which are characteristic of *Avicula*; but we meet, on the other hand, with the coarsely-corrugated and somewhat tubular structure of the *Pectenidæ*."[1] I am not acquainted with the character of the cartilage-pit, and the muscular impressions of the shells, which Bronn, Münster, and Goldfuss have placed in *Monotis;* but as their external form closely resembles that of the fossils about to be introduced, I am induced to place it in this genus.

Monotis speluncaria, *Schlotheim*. Plate XIII, figs. 5 to 21.

Gryphites speluncarius, *Schl.* Akad. Münch., p. 30, pl. v, fig. 1 *a*, *b*, *c*, 1816.
— — ,, Petrefactenkunde, p. 292, 1820.
— — ,, Boué, Edin. Phil. Journ., vol. xii, p. 144, 1825.
Productus — ,, Brongniart, Tab. de Ter., p. 425, 1829.
Avicula gryphæoides, *J. de C. Sow.* Trans. Geol. Soc. Lond., 2d series, vol. iii, p. 119, 1829.
— — ,, De la Beche, Geol. Man., p. 384, 1831; Germ. Transl., p. 459, 1832; 3d English ed., p. 573, 1833.
Producta speluncaria, *Schl.* Op. cit.
— — ,, Phillips, Encyc. Met., vol. iv, p. 617, 1834.
Avicula gryphæoides, *J. de C. Sow.* Op. cit., p. 617, pl. iii, fig. 6 *a*, *b*.
— speluncaria, *Schl.* Quenstedt, Wiegmann's Archiv, p. 82, pl. i, fig. 1, vol. i, 1835.
Producta — ,, Thomson, Outlines Min. Geol. &c., vol. ii, p. 326, 1836.
Avicula gryphæoides, *J. de C. Sow.* Op. cit., p. 318.
— — ,, Phillips, Lardner's Cycl., Geology, vol. i, p. 190, fig. 3, 1837.
— speluncaria, *Schl.* Geinitz, Leonhard u. Bronn's Neues Jahrbuch, p. 639, 1841.
— — ,, Morris, Catalogue, p. 107, 1843.
— — ,, Geinitz, Gæa von Sachsen, p. 96, 1843.

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[1] Report of the Fourteenth Meeting of the British Association, p. 20, 1844. A specimen of an allied species, *Avicula longicostata*, Stutchbury, in the Bristol Museum, possesses a single sub-central muscular impression, as in *Monotis speluncaria*.

Avicula speluncaria, *Schl.* De Verneuil, Bull. Soc. Géol. de France, 2me série, vol. i, p. 33, 1844.
— — „ Geol. Russ., vol. i, p. 224, 1845.
— — „ Keyserling, Petschora-land, p. 248, 1846.
— — „ Tennant, Strat. List, p. 88, 1847.
Monotis — „ King, Catalogue, p. 9, 1848.
— gryphæoides, *J. de C. Sow.* Howse, Trans. T. N. F. C., vol. i, p. 249, 1848.
Avicula speluncaria, *Schl.* Geinitz, Versteinerungen, p. 10, pl. iv, figs. 18, 19, 1848.
— Kazanensis, *De Verneuil.* Op. cit., p. 10, pl. iv, figs. 20, 21.

Diagnosis.—Sub-hemispherical; one inch and a quarter in diameter; slightly inequilateral, the posterior side being the largest; with a short straight hinge-line. *Upper valve* lobed on its posterior side; with numerous radiating fine, and a few strong, ribs; and rather prominent lamellæ of growth, the latter often rising vaultedly from under each other on the strongest ribs: *umbone* rounded, incurved, and projecting behind the hinge. *Small valve* disciform; finely radiately striated: *byssal notch* deep; passing nearly to the centre of the hinge.

Monotis speluncaria is a variable species in many respects: in general the ribs curve towards the posterior side of the shell (vide Pl. XIII, fig. 5); but in some specimens they display a tendency to curve in the contrary direction (vide Pl. XIII, fig. 13). In the specimen last cited the large valve is oblique towards the anterior direction; whereas, in general, the obliquity is posteriorly directed: the specimen represented in Pl. XIII, fig. 12, is strongly obliquated in the usual direction. In many specimens the ribs are of different sizes, every third or fourth rib being larger than the three or four intermediate ones: the fossils represented in Pl. XIII, figs. 13, 17, are instructive examples in this respect, and show that the specimens identified by Dr. Geinitz (vide Versteinerungen, pl. iv, figs. 20, 21) with De Verneuil's *Avicula Kazanensis*, are merely varieties of the present species. The lamellæ of growth, as they pass over the large ribs, are generally vaulted (vide Pl. XIII, fig. 5); but in some specimens, especially those occurring at Silksworth (vide Pl. XIII, fig. 21), they become tubular. Occasionally a variety is found entirely without ribs, as represented in Pl. XIII, fig. 11. My largest specimen, the one represented in Pl. XIII, fig. 20, and exhibiting the adductor, pedal, and pallial muscular impressions, measures an inch and a half in diameter.

M. de Verneuil has described a Russian Permian shell under the name of *Avicula Kazanensis*, which has some resemblance to the present species, but differs from it in having a long straight hinge; in being more produced in the cardino-frontal region, and more decidedly obliquated. The three specimens figured in the 'Geology of Russia,' pl. xx, figs. 14 *a*, *b*, *c*, do not all appear to belong to *A. Kazanensis*, inasmuch as fig. 14 *c* (which represents the flat valve), from its slight obliquity, and its radiating lines, might readily be taken for a *Monotis speluncaria*, were it not that its notch is far from being so deep as it is in the latter.

Monotis speluncaria is a common fossil, both in Germany and England. Von

Schlotheim, who gave some excellent representations of it in the 'Denkschriften der Königlichen Akademie zu München,' was the first to make it known, as occurring at Glücksbrunn. Dr. Geinitz notices its being found in the lower Zechstein of Corbusen; in the upper Zechstein at Roschütz; and in the Zechstein-dolomite of Pössneck, Könitz, Altenstein, &c. In England it is found in the Shell-limestone of Humbleton Quarry, Ryhope Field-house Farm, Dalton-le-Dale, Tunstall Hill, Silksworth, Hylton North Farm, north end of Black Hall rocks, and Castle Eden Dene. A few examples occurred to me in the breccia of Tynemouth Cliff; and a single specimen in the fragment of Magnesian Limestone dredged up near the Dogger Bank. M. de Verneuil and Count Keyserling notice specimens found in the Russian Permian rocks near Arzamas, and of Ust-Joschuga, apparently belonging to this species. Is the flat valve, already noticed, as resembling *Monotis speluncaria*, from the same deposit containing *M. Kazanensis*, and from the neighbourhood of Kazan?

MONOTIS RADIALIS, *Phillips*. Plate XIII, figs. 22, 23.

(?) PECTEN, SP. 2, (S. N.), *J. de C. Sow.* Trans. Geol. Soc. Lond., 2d series, vol. iii, p. 120, 1829.
PECTEN RADIALIS, *Phillips*. Encyc. Met., vol. iv, pl. iii, fig. 5, 1834.
MONOTIS — ,, King, Catalogue, p. 9, 1848.

Diagnosis.—Somewhat elliptical longitudinally in its marginal outline; with a short, straight, hinge-line. *Large valve* with numerous, fine, radiating, slightly tuberculated ribs; and a very small umbone. *Small valve* (unknown).

This species might be taken for a flattened variety of *Monotis speluncaria*, a view which I am certainly not prepared to urge any strong objection against; but it differs therefrom in having a very slightly developed umbone, and in being a narrower and longer shell. It varies equally as much as the latter in its marginal outline and superficial ornamentation (vide Pl. XIII, figs. 22, 23). Professor Phillips describes it as being "convex, circular, marked with striæ, slightly tuberculated; about the same size as" *Pecten pusillus;* which is perhaps a hurriedly drawn-up description, as the specimen figured in the 'Encyclopædia Metropolitana' is much larger, and clearly the present species.

Monotis radialis occurred to Professor Phillips in the Shell-limestone of Humbleton, which is the only locality for it known to me.

MONOTIS GARFORTHENSIS, *King*. Plate XIII, fig. 24 and (?) fig. 25.

Diagnosis.—Upper valve moderately convex; with numerous fine radiating tubuliferous ribs, and a moderate-sized umbone.

From the imperfect state of the only specimen I have seen of this species, it is impossible for me to draw up any other than a provisional description of it. The specimen is represented of the natural size in Pl. XIII, fig. 24; but unfortunately, owing to its not being sufficiently cleared of the matrix, its marginal outline cannot be correctly delineated or determined.

It agrees with certain varieties of *Monotis speluncaria* in its tubuliferous ribs: it also bears some resemblance to Schlotheim's *Ostracites spondyloides* of the Muschelkalk.

Mr. E. Charlesworth has kindly allowed me to represent a testiferous specimen (vide Pl. XIII, fig. 25[1]), found in the same locality where the present species occurs, and exhibiting the inner surface of the flat or lower valve. It closely resembles the corresponding valve of *Monotis speluncaria*, except in being thinner: it is probably the under valve of *Monotis Garforthensis*.

The specimen represented in Pl. XIII, fig. 24, belongs to the York Museum (ticketed No. 8837), and was found at Garforth.

Order Dimyaria, Lamarck.

Diagnosis.—The valves attached to each other by two muscles laterallv situated.

Family Mytilidæ (*les Moules*), Cuvier.

The common Mussel is the type of this group.

Genus *Mytilus*, Linnæus.

Diagnosis.—"Shell equivalve, very inequilateral, subtriangular, more or less tumid, surface covered with an epidermis; beak terminal. Hinge without teeth, though often more or less denticulated; ligament linear, internal; two unequal muscular impressions; pallial impression obscure, simple."[2]

This group is represented by the common Mussel.

The shells next to be noticed do not seem to belong to the present genus, at least, as it is generally defined, and judging of it by the characters of its typical species. Instead of having the cartilage nearly concealed, situated in a fissure wider at the bottom than at the top, and covered with the hinge-margins, they have it exposed, and situated in a furrow wider at the top than at the bottom. They differ also from *Mytilus*, as above described, in being inequivalved, and in having the anterior adductor muscle attached to, and passing between, two oblique or horizontal plates in the point of the umbonal

[1] The portion on the left side of the line on the left side of the figure is restored.

[2] Forbes and Hanley, British Mollusca, vol. ii, p. 168.

cavity.[1] Dr. de Koninck has described a genus under the name of *Myalina*,[2] which is perhaps the proper receptacle for these shells; but I am averse to placing them in it, in consequence of there being one or more Neocomian *inequivalved* Mussels (e. g. *Mytilus inæquivalvis*), and some recent species (*M. bilocularis*, &c.) with *umbonal transverse plates*.[3] Perhaps there are some true Mussels in which the cartilage is exposed, and placed in a furrow, as in the two Permian species. The latter have the cartilage-plates or fulcra parallelly grooved as they are in *Myalina* (vide Pl. XIV, fig. 13). The *Mytilus crassus*, Fleming, belongs to De Koninck's genus; and all the modioliform shells described by J. de C. Sowerby in Mr. J. Prestwich's Memoir 'On the Geology of the Coal-field of Coalbrook Dale' (vide Trans. Geol. Soc. Lond., 2d series, vol. v, Pl. XXXIX, figs. 10, 15—18), appear to be congeneric species. As I strongly suspect these were all fresh- or brackish-water shells, one is seemingly warranted in characterising *Myalina* as a fresh-water genus. The next question for consideration is, whether it possessed any marine species. If the Permian forms belong to De Koninck's genus,—*Myalina*, like some other genera, may be said to contain both kinds, as they were undoubtedly oceanic shells.

MYTILUS SQUAMOSUS, *J. de C. Sowerby*. Plate XIV, figs. 1, 2, 3, 4, 5, 6, 7.

CASTS OF BIVALVES RESEMBLING MUSCLES, *Winch*. Trans. Geol. Soc. Lond., vol. iv, p. 10, 1817.

(?) MYTYLUS, N.S., *Phillips*. Phil. Mag., vol. iv, p. 403, 1828.

— SQUAMOSUS, *J. de C. Sow*. Trans. Geol. Soc. Lond., 2d series, vol. iii, p. 120, 1829.

— — ,, De la Beche, Geol. Man., p. 385, 1831; Germ. Transl., p. 459, 1832; 3d Eng. ed., p. 573, 1833.

— — ,, Phillips, Encyc. Met., vol. iv, p. 616, 1834.

— — ,, Thomson, Outlines of Min. Geol. &c., vol. ii, p. 316, 1836.

— HAUSMANNI, *Goldfuss*. Petrefacta, part ii, p. 168, pl. 138, fig. 4, 1837.

— ACUMINATUS, *J. de C. Sow*. Phillips, Lardner's Cyclop., Geology, vol. i, p. 190, fig. 2, 1837.

GERVILLIA, Geinitz, Leonhard u Bronn's Neues Jahrbuch, p. 639, 1841.

MYTILUS SQUAMOSUS, *J. de C. Sow*. Morris, Catalogue, p. 93, 1843.

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[1] The situation of the anterior adductor muscle is shown by the cast of the space intervening the horizontal plates (that is, the prolongation between the umbones in the cast represented in Plate XIV. fig. 5) displaying its impressions: these are seen on the prolongation; but they cannot be represented in the figure. Through an oversight, the impression marked *c* in fig. 7, Pl. XIV, is referred to the anterior adductor muscle in the explanation appended to the plate: it ought to have been named *the impression of the anterior visceral or pedal muscle*.

[2] Description des Animaux fossiles, qui se trouvent dans le terrain carbonifère de Belgique, p. 125.

[3] The genus *Dreissina*, being a fresh-water group, is not taken into consideration.

GERVILLIA . . . . . ? Geinitz, Gæa von Sachsen, p. 96, 1843.
MYTILUS ACUMINATUS, *J. de C. Sow.* De Verneuil, Bull. Soc. Géol. de France, 2me série, vol. i, p. 32, 1844.
— — „ Geol. Russ., vol. i, p. 224, 1845.
— HAUSMANNI, *Goldfuss.* Geinitz, Grundriss, p. 453, 1846.
— ACUMINATUS, *J. de C. Sow.* Tennant, Strat. List, p. 88, 1847.
— HAUSMANNI, *Goldfuss.* King, Catalogue, p. 9, 1848.
— ACUMINATUS, *J. de C. Sow.* Howse, Trans. T. N. F. C., vol. i, p. 248, 1848.
— HAUSMANNI, *Goldfuss.* Geinitz, Versteinerungen, pp. 9, 10, pl. iv, figs. 12, &c., 1848.

Diagnosis.—"Ovate, acuminate, the laminæ of the shell having the appearance of scales; length more than an inch." J. de C. Sowerby.[1]

Having examined the originals of this species in Mr. J. de C. Sowerby's collection, I have ascertained that they are identical with the shells noticed in the above synonymy.[2]

As J. de C. Sowerby and Goldfuss have overlooked two or three important characters of this interesting species, it is necessary for me to add, that it is inequivalved; has ecurved umbones, a horizontal septum within the umbonal cavity of each valve, and a wide longitudinally-grooved cartilage-furrow or fulcrum. Its muscular system has already been noticed; but it may be added, that the anterior visceral or pedal muscles, judging from the position of their impressions (vide Pl. XIV, fig. 7 *c*), have been situated much further back than is usual in *Mytilus:* the relative position of the posterior adductor and posterior visceral muscular impressions is correctly represented in the figure just noticed: the pallial line is even more strongly displayed on the fossil than it is in fig. 6. It is very often found nearly smooth, as in fig. 3; but under more favorable conditions, its squamose character, which results from the prominency of the incremental laminæ, is finely displayed, as in the specimen represented in fig. 4.

Mytilus squamosus is a widely-distributed species. "It occurs in considerable abundance near Ferry Bridge, but generally in the form of casts" (Sedgwick, Geol. Trans., 2d series, vol. iii, p. 120). The instructive specimen represented in Pl. XIV, figs. 6, 7, was collected by Mr. Binney at Hampole, in Yorkshire. It also occurs at Tunstall Hill, Dalton-le-Dale, Humbleton Quarry, and Silksworth. Dr. Geinitz records its occurrence in the upper Zechstein of Paschkowitz, Cosma, Lehndorf, Sommeritz, Schmölln, Roschütz, Kamsdorf, Elgersburg, Roda, Salzungen, Ahlstedt, Osterode, and Neuhof; also in the Dolomite of Mühlberg and Scharzfeld.

[1] Trans. Geol. Soc. Lond., 2d series, vol. iii, p. 120. The following is Dr. Goldfuss's diagnosis: "Myt. testa ovata-acuta convexa lamellosa, umbonibus acutis, margine cardinali recto, latere inferiore declivi, lineis concentricis subdistantibus." (Petrefacta, p. 168.)

[2] *Mytilus Hausmanni*, Goldf., was incorrectly identified with *Modiola acuminata* in my 'Catalogue,' p. 9.

MYTILUS SEPTIFER, *King*. Plate XIV, figs. 8, 9, 10, 11, 12, 13.

MODIOLA ACUMINATA,[1] *J. de C. Sow.* Trans. Geol. Soc. Lond., 2d series, vol. iii, p. 119, 1829.
— — „ De la Beche, Geol. Man., p. 385, 1831 ; Germ. Transl., p. 459, 1832; 3d Eng. ed., p. 573, 1833.
— — „ Phillips, Encyc. Met., vol. iv, p. 616, 1834.
— — „ Thomson, Outlines of Min. Geol. &c., vol. ii, p. 316, 1836.
— — „ Morris, Catalogue, p. 91, 1843.
MYTILUS SEPTIFER, *King*. De Verneuil, Bull. Soc. Géol. de France, 2me série, vol. i, p. 32, 1844.
OSTREA ? PUSILLA (young), *King*. Op. cit., p. 34.
MYTILUS SEPTIFER „ Geol. Russ., vol. i, p. 224, 1845.
OSTREA PUSILLA (young), „ Op. cit., p. 225.
(?) MYTILUS HAUSMANNI, *Goldfuss*. Keyserling, Petschora-land, p. 260, pl. xiv, figs. 2, 2 *a*, 1846.
— SEPTIFER „ Tennant, Strat. List., p. 88, 1847.
— — „ King, Catalogue, p. 10, 1848.
OSTREA ? TAYLORIANA (young), *King*. Op. cit. p. 9.
MYTILUS SQUAMOSUS, *J. de C. Sow.* Howse, Trans. T. N. F. C., vol. i, p. 248, 1848.
(?) — HAUSMANNI, *Goldfuss*. Geinitz, Versteinerungen, pl. iv, fig. 14, 1848.

Diagnosis.—Inequivalve: tumid: rhomboidal marginally, the hinge line being slightly oblique (in old specimens) to the anterior and posterior margins: three quarters of an inch long, and half an inch wide: with foliaceous laminæ of growth. *Umbones* ecurved at the point. *Umbonal cavities,* each with an oblique plate serving as a fulcrum for the anterior adductor muscle.

"This species, a shorter and wider one than the last, is lobed in front like a Modiola, and furnished with a ridge that posteriorly bounds the anterior adductor muscular impressions."[2]

The form of *Mytilus septifer* varies with age, young specimens being more oblique and narrower than old ones. It was this circumstance that led me into the error of considering some single valves of very young individuals to belong to a distinct shell, which I named in my 'Catalogue' *Ostrea ? Tayloriana.* The ridge or plate in the umbonal cavities is also somewhat variable, being more oblique when the shell is young than when it is old; but in both cases, although it "posteriorly bounds the anterior adductor muscular impressions," it has obviously served as a fulcrum for the producing muscle.[3]

[1] Mr. Sowerby's specific name having been anticipated by Schlotheim's *Mytilites acuminatus,* for another shell, it has been deemed necessary to employ that of *septifer* for the present species.

[2] King, Catalogue, p. 10.

[3] It is difficult to represent the anterior adductor muscular impressions on casts, as the curving of the umbones prevents their being properly seen: the impression *a,* in fig. 11, Pl. XIV, ought to have been placed much further forward, where in fact it cannot be represented in the figure.

Mytilus septifer occurs "at Byers's Quarry, Whitburn, Roker, Suter Point, and Marsden, in a formation probably the equivalent of the German Rauchwacke" (Catalogue, p. 10); also in the same formation south of Black Hall Rocks on the coast of Durham (Sedgwick). Specimens of what is considered "a larger species, length half an inch" (but perhaps only an enlarged form of the present one), "occurs in the upper thin-bedded limestone at Cold Hill, a few miles east of Aberford" (Sedgwick). It probably occurs in some of the Zechsteins of Germany. Count Keyserling figures a fossil under the name of *Mytilus Hausmanni* (but which, I suspect, belongs to the present species), found in the Permian rocks of Petschora-land.

Family Edmondiidæ, *King*.

This is a provisional group supposed to be related to *Mytilidæ*, concluding from the internal cartilage fulcra, edentulous hinge, and entire pallial line of its type.

Genus *Edmondia*, De Koninck, 1843.

Sanguinolaria, *Auct.*
Isocardia (*unioniformis*), *Phillips.*
Sanguinolites (*angustata*, Phillips), *M'Coy*, 1844.

Diagnosis.—"Shell tumid, equivalved, unequilateral, transverso-suboval, or rounded, striated transversely, the lunula gaping; no hinge teeth; hinge with a small transverse thin plate, internal, greatly strengthened by an internal ligament." [1] (De Koninck.)

Type, *Isocardia unioniformis*, Phillips.

In the 'Annals and Magazine of Natural History' for November, 1845, I published an account of a new genus, as a receptacle for certain fossils which had been generally placed in *Sanguinolaria*. The characters of the genus were principally derived from two species apparently closely related to each other, viz. *Sanguinolaria sulcata*, Phillips, and *Hiatella sulcata*,[2] Fleming. Although closely resembling each other, these species

[1] "Testa tumida, æquivalvis, inæquilatera, transverso-subovalis, vel rotundata, transversim striata; lunulâ hiante; dentibus cardinalibus nullis; cardine lamella transversa, internâ, ligamento interno idoneâ, munito." Vide Description des Animaux Fossiles qui se trouvent dans le ter. carb. de Belgique. The following is Dr. de Koninck's French description: "Coquille renflée, equivalve, inequilateral, transverse, subovale, ou arrondie, couverte de stries nombreuses, transverses et concentriques; lunule échancrée; charnière dépourvue de dents, remplacées par une lamelle transverse, etroite, profondement située et en partie recouverte par le crochet et ayant probablement servi à supporter un ligament interne, d'une forme à peu près analogue." (Loc. cit.)

[2] In my paper referred to in the text, this shell is identified with the *Pholodomya elongata* of Dr. Morton (vide Ann. and Mag. of Nat. Hist., vol. xiv, pp. 316-17); but since it was written, I have ascertained that the shell named *Hiatella sulcata* by Dr. Fleming, in his 'British Animals,' p. 463, is the same species, and consequently quite distinct from the *Sanguinolaria sulcata* of Professor Phillips, who was disposed to regard both as specifically identical. I had long suspected the shell in question to be the same as Dr. Fleming's *Hiatella sulcata*, from its agreeing with this species in being "closely and obsoletely striated longitudinally, the striæ consisting of minute tubercles," as displayed in the specimen represented in figure 5, Plate XX,

differ remarkably in the position of their cartilage fulcra, which in the former are lamelliform, elongated in the direction of the cardinal line, and, as in *Lutraria elliptica*, directed downwards within the dorsal cavity (vide Pl. XX, figs. 2 *a*, 3, 4); while in the latter they are external, and of the ordinary form. On examining another species somewhat resembling them, and which I provisionally named *Allorisma constricta*,[1] the cartilage fulcra appeared to occupy an intermediate position. Hence I was led to consider that these shells were furnished with cartilage fulcra, varying from an internal to an external position; and that they constituted a generic group, for which I proposed the name *Allorisma*. Moreover, I predicated of the genus a character which was displayed on several of my specimens of the so-called *Hiatella sulcata*, viz. a sinus in the pallial line (vide Pl. XX, fig. 5 *c*). It happens, however, that the last noticed character was based on insufficient data; that, in fact, the pallial line, which I had not then seen, of *Sanguinolaria sulcata* is entire, or, in other words, not sinuated, as was subsequently pointed out by Mr. Morris.[2] At the time this gentleman's discovery was published, I ascertained that the *Isocardia unioniformis*, Phillips, possessed a pair of cartilage fulcra, similar to those of *Sanguinolaria sulcata*, and an entire pallial line:[3] this led me to the consideration of De Koninck's genus *Edmondia*, which is typified with the former species.

I now ascertained that Dr. Koninck had anticipated me in the discovery of the vertical cartilage fulcra, which he describes singly as "une lamelle transverse, étroite, profondément située et en partie recouverte par le crochet et ayant probablement servi à supporter un ligament interne, d'une forme à peu près analogue." It will thus be evident, that in constructing the genus *Allorisma*, I have erred in placing together two widely-different kinds of shells,—the one (with the sinuated pallial line) having been inhabited by a mollusk with an anal and a branchial siphon,—the other (with the entire pallial line), by a mollusk unprovided with these appendages. It is equally evident, as regards the latter kind, the one represented by *Sanguinolaria sulcata*, that the

—a character which was noticed in my paper (p. 316). This suspicion is now confirmed by the following extract from a letter with which I have been favoured by Dr. Fleming, to whom I forwarded a couple of specimens of this shell for comparison: "two of the shells do certainly resemble my *Hiatella sulcata*: on one of the casts there are traces of the striæ, a character rarely to be met with owing to the extreme thinness of the shell, and its usual imperfectly preserved state."

[1] As this shell has apparently not been described, I venture to publish the following diagnosis of it.

Allorisma constricta, King. Twice as wide as it is long. *Umbones* tumid; incurved; approximating; projecting behind the hinge; situated a little behind the centre of the anterior half of the shell. *Valves* with a slight longitudinal constriction immediately in front of the umbones; transversely ribbed; marked with faint incremental lines. *Ribs* rather faint, and obliquely crossed with the incremental lines on the anterior third of the shell; dichotomised on the constriction; and rather prominent on the rest of the valves, except on their dorsal slope. *Lunule* oblong, and shallow. *Corselet* long, and rather deep. *Dorsal line* slightly concave; *ventral*, flatly convex; *anterior*, evenly rounded; *posterior*, obliquely rounded. *Pallial muscular sinus* shallow. Found in the Carboniferous shales, Redesdale, Northumberland. My largest specimen is two inches and a half wide.

[2] Strzelecki's Physical Description of New South Wales, &c., p. 270.

[3] Specimens of this shell, and other allied species, showing an entire pallial line, I first saw in the valuable ocal collection of carboniferous fossils belonging to the Rev. Mr. Jenkinson of Lowick, Northumberland.

establishing of the genus *Edmondia* by De Koninck renders it necessary for me to modify *Allorisma* by restricting it to the kind represented by *Hiatella sulcata*. Another opportunity will herein occur to speak more in detail of the latter genus.

There is much difficulty in distinguishing the various species of *Edmondia*, in consequence of their resembling forms belonging to other genera, and rarely displaying the essential characters of the genus. Thus the generic collocation of the so-called *Sanguinolaria undata*, Portlock, is far from being correctly determined. I am inclined to think, if this species is not an *Edmondia*, that it belongs to a genus closely related to it; as there is some appearance of a deep vertical cartilage-plate (though much reduced in size, compared with that of *Edmondia sulcata*, *Ed. unioniformis*, and other species), occupying about one third of the length of the dorsal margin of the valves: perhaps it belongs to the genus *Orthonota* of Conrad, which is typified by a similarly-formed shell, the *Orthonota undulata*, Conrad, characteristic of the Hamilton group of rocks (Devonian) in North America.

Synonymous with *Edmondia* is Professor M'Coy's *Sanguinolites*,[1] which is typified with Phillips's *Sanguinolaria* (?) *angustata*, a species having (as well as the one [*Sanguinolaria arcuata*, Phillips] next in order of description in the 'Synopsis of the Carboniferous Fossils of Ireland')[2] all the characters of the present genus.[3]

Edmondia appears to be a singular genus, both in its cartilage fulcra and muscular system. The former, as existing in *Edmondia sulcata* (*Sanguinolaria id.*, Phillips), are represented in Plate XX, figs. 2 *a*, 3, and 4. By referring to these figures, it will be seen that the plates are situated within the umbonal cavity, and have a striking resemblance to a bivalve shell. The figures cited are copies of a fossil (cast) which was originally in the state represented in figure 1; but by carefully chipping off the umbones, it was made to display two plates, singly curving within each of the umbonal cavities, as in figure 2 *a*: both occupy their exact relative position in (the magnified) figure 4; and figure 3 is an enlarged representation of the most perfect one. Having broken off the umbones of a number of specimens with the like result, I can speak with confidence as to these plates belonging to the shell; and I am equally confident, from what is displayed in several sections which I have made of the shell from the dorsal to the ventral margin, that each one is attached by its upper margin to the hinge-plate in both valves. Looking at such shells as *Lutraria elliptica*, we discover that similar structures serve as supports or fulcra for the cartilage: we are therefore led to conclude that the plates of the fossil under consideration have

[1] Vide Synopsis of the Carboniferous Fossils of Ireland, p. 47.

[2] A specimen of *Sanguinolaria* (?) *angustata* in the Gilbertsonian collection of the British Museum, exhibits the groove left by one of the cartilage fulcra: casts of *Sanguinolaria arcuata*, with the grooves left by the cartilage fulcra, are rather common at Redesdale in Northumberland.

[3] Professor M'Coy has included species of various genera in his *Sanguinolites*: some appear to be *Allorismas* (e. g., *Sanguinolaria tumida*, Phillips); and others *Pleurophoruses* (*Sang. tricostata*, Portlock): *S. undatus* is perhaps an *Orthonota*; *S. contortus* appears to belong to an undescribed genus; and *S. radiatus* is seemingly a *Janeia*.

answered a similar purpose,—a conclusion powerfully supported by an examination of *Modiola vulgaris*, in which the cartilage is internal, and attached to the surface of an excavation in the thickness of both hinge-plates. Now it is not difficult to comprehend how easily such a fulcrum could become modified into that of *Edmondia*, by the inferior margin of each excavated surface becoming more and more projected from the hinge-plate. A modification of this kind is instructively illustrated by the cartilage fulcral plates, or spoon-shaped processes, in both valves of *Mya truncata*.

It remains to be observed, that the cartilage-plates in *Edmondia* vary somewhat in direction, according to species. In *Edmondia unioniformis* (*Isocardia id.*, Phillips), and *Ed. Murchisoniana*, they are closer to the surface of the umbonal cavities than in *E. sulcata*.[1]

The wide space between the cartilage-plates of the present genus indicates that the cartilage has been of considerable thickness; but it does not appear to have been much thicker than that of *Modiola*, *Lutraria*, and *Mya*.

The anterior portion of the muscular system of *Edmondia* is somewhat peculiar. In good casts of *Edmondia sulcata* there are four muscular impressions in front of the umbone; two large ones perpendicularly situated (the uppermost, which is half the size of the lowest, is bounded posteriorly by a slightly elevated ridge), and other two, which are very small, situated between and at right angles to the former. The lowest of the large impressions may be safely referred to the anterior adductor muscle; while the uppermost, together with the two small ones, I am of opinion belonged to the visceral or pedal muscles. The large size of the uppermost muscular impression is seemingly indicative of the Mollusk having had a large foot, as is the case with *Unionidæ* and some other families.

Concluding from what is at present known, the existence of *Edmondia* appears to have been confined to the close of the primary period; as species are not yet known to occur in any other than the Carboniferous and Permian formations.

Edmondia Murchisoniana, *King*. Plate XIV, figs. 14, 15, 16, 17.

Edmondia Murchisoniana, *King*. Catalogue, p. 10, 1848.
— elongata, *Howse*. Trans. T. N. F. C., vol. i, p. 243, 1848.

Diagnosis.—Transversely oblong; inequilateral; rather tumid; slightly wrinkled, and finely striated parallel to the margins. Half an inch in width, and three eighths in length. *Valves* with a rectilinear hinge-margin, obtusely rounded or somewhat squared lateral extremities, and a flatly convex ventral margin. *Cartilage-fulcra* half the length of the cardinal line; strongly curving within the umbonal cavities; with the free margin of their anterior half deeply sinuated.

[1] The character of the cartilage fulcra of *Edmondia* is strikingly simulated by the posterior adductor muscular plates of *Teredo navalis*; and very singularly so by those of *T. bipennata*, in which they are actually external, being elevated above the dorsal margin of the valves.

This pretty species, which is dedicated to the accomplished founder of the "Permian System," has some resemblance to the so-called *Sanguinolaria truncata*, Goldfuss, which differs, however, in having a subarcuated hinge-line. It also resembles young specimens of *Edmondia unioniformis*, Phillips, except that the latter is grooved, and not striated.

The dorsal and ventral margins of *Edmondia Murchisoniana* are nearly parallel to each other. The valves are evenly convex, owing to which character the umbones are only slightly prominent. A rather long, slightly-developed, curving ridge posteriorly bounds the anterior muscular impressions. The cartilage-fulcra (vide Pl. XIV, fig. 17 *a*), when the valves are closed, have a striking resemblance to a *Gastrochæna*,—the arcuation of their anterior margin producing a gape resembling that of the latter shell. My largest specimen measures an inch in width.

Edmondia Murchisoniana is a rare species, having only been found in the Shell-limestone of Humbleton Quarry and Tunstall Hill.

Family Bakevelliidæ, King.

The present group appears to be related to *Mytilidæ* and *Arcidæ*.

Genus *Bakevellia*,[1] King, 1848.

Diagnosis.—Aviculoid: biareagerous: inequivalved, the right valve being the smallest. *Teeth* linear; situated at the terminations of the hinge. *Cartilage* divided; fitting into pits excavated in the hinge-areas. *Valves* sinuated in the anterio-ventral margin for the passage of the foot or byssus.

Type *Avicula antiqua*, Münster.

"This genus is proposed for some inequivalve shells hitherto placed in *Avicula*. It possessed two adductor muscles,[2] and therefore has no relation to *Avicula*, which is a true Monomyarian:[3] further, it is furnished with a plurality of cartilage-pits (from

[1] Named after the late Mr. Bakewell; as his instructive 'Introduction to Geology' was the first work on the subject I read.

[2] Vide Plate XIV, fig. 33 *a*, *b*.

[3] Contradictory views are held regarding the number of adductor muscles of *Avicula*. Deshayes, in the last edition of Lamarck (vol. vii, p. 95), states that there is only one; while Mr. Gray asserts there are two (vide Synopsis of the British Museum, p. 118, June 17, 1841): Forbes and Hanley, speaking of the family *Aviculidæ*, state, that in it "we have a passage from the dimyarian to the monomyarian Lamellibranchiate bivalves, great groups, which, though convenient sections, can scarcely be regarded as of ordinal value." (Vide Brit. Moll., vol. ii, p. 250.) The question involved in this passage is of the utmost importance in a classification of the *Lamellibranchiata*; it is therefore to be regretted that the authors of the 'British Mollusca' have thus summarily disposed of it. My own examination of a Mediterranean specimen of *Avicula Tarentina* is confirmatory of M. Deshayes' statement; inasmuch as I have been unable to discover an anterior adductor muscle in this shell: those occupying its place are the anterior visceral or pedal muscles: the *posterior* pedal muscles are unusually large, and attached close to, and in front of, the subcentrically situated adductor muscle: perhaps the former have been taken for the anterior or extra adductor?

two to five, according to species), as in *Perna* and *Gervillia;* and it possesses anterior and posterior linear teeth,[1] similar to those of the Cucullæa-toothed Arks."[2]

Until more is known of the general characters and chronogeny of a number of palæozoic fossils apparently belonging to *Pterinea*, Goldfuss, *Actinodonta*, Phillips, *Modiolopsis*, Hall, *Myalina*, Koninck, and some undescribed genera, it is impossible to speak with any safety as to the affinities of the present genus, or even the family which it typifies. "*Bakevellia* appears to be related to *Pterinea;* but the latter has no cartilage-pits:" its resemblance to *Avicula* is purely simulatory.

Bakevellia ceratophaga, *Schlotheim.* Plate XIV, figs. 24, 25, 26, 27.

Mytilites keratophagus, *Schl.*	Akad. Münch., vol. vi, p. 30, pl. v, fig. 2 *a*, *b*, *c*, 1816.
— ceratophagus, „	Petrefactenkunde, p. 293, 1820.
— — „	Boué, Edin. Phil. Journ., vol. xii, p. 144, 1825.
Avicula—striated sp., which resembles a Gervillia, *J. de C. Sow.*	Trans. Geol. Soc. Lond., 2d series, vol. iii, p. 119, 1829.
Mytilus keratophagus, *Schl.*	De la Beche, Geol. Man., Germ. Transl., p. 459, 1832; 3d Eng. Ed., p. 573, 1833.
— ? — „	Phillips, Encyc. Met., vol. iv, p. 617, 1834.
Avicula ceratophaga „	Goldfuss, Petrefacta, 2d part, p. 126, pl. 116, fig. 6.
— keratophaga „	Geinitz, Gæa von Sachsen, p. 96, 1843.
— — „	De Verneuil, Bull. Soc. Géol. de France, 2me série, t. i, p. 33, 1844.
— — „	Geol. Russ., vol. i, p. 224, 1845.
— — „	Geinitz, Grundriss, p. 457, 1846.
— — „	Tennant, Strat. List, p. 88, 1847.
Bakevellia ceratophaga „	King, Catalogue, p. 10, 1848.
Avicula keratophaga „	Howse, Trans. T. N. F. C., vol. i, p. 249, 1848.
Gervillia — „	Geinitz, Versteinerungen, p. 10, pl. iv, figs. 16, 17, 1848.

Diagnosis.—"Shell subrhomboidal, arched, the front wing rounded, the one behind falciform produced, with regular concentric lines."[3]

Bakevellia ceratophaga is so truly like an *Avicula*, in its long hinge-line, slight umbonal divarication, prominent incremental lines, long posterior wing, anterior lobe, and byssal or pedal sinus, that Schlotheim, who published some excellent figures of it, was struck with its "resemblance to young specimens of *Mytilus hirundo*, Linn."[4]

It is somewhat variable in form; but its distinctive characters are easily recognised in the line of separation, between the convexity of the upper or large valve and the area of the wing, being abrupt, well defined, and slightly oblique to the cardinal line; and

[1] Vide Plate XIV, fig. 34.

[2] King, Catalogue, p. 10.

[3] "Avicula testa subrhomboidali fornicata, ala antica rotundata postica falciformi producta, lineis concentricis regularibus." (Goldfuss, Petrefacta, 2d part, p. 126.)

[4] Denkschriften der Königlichen Akademie zu München, vol. vi, p. 30.

in the deep sinus of the wing-area. "The line of separation" noticed is not so prominent on the under or small valve. The hinge-area possesses six or more cartilage-pits. It is a beautifully striated species. The Carboniferous *Gervillia laminosa*, Phillips, appears to be an allied form.

Bakevellia ceratophaga occurs rather rarely in the Shell-limestone of Humbleton Quarry and Tunstall Hill. It has been noticed in a locality one mile north-west of Pontefract. The Doggerbank fragment of Limestone contained a single specimen. Another specimen occurred to me in the Breccia of Tynemouth Cliff. Dr. Geinitz having confounded this species with the following one, it is difficult to speak precisely as to its German habitats: probably both species agree in this respect: the following localities from the 'Versteinerungen' (p. 10) are therefore given on this supposition: "rarely in the under Zechstein of Corbusen, Duchy of Altenberg; in the Limestone between the Weissliegenden and Kupferschiefer, also in the Zechstein of Kamsdorf and Seissla near Könitz; in the upper Zechstein of Roschütz near Gera, Herges in the Schmalkalden province, Hirschberg near Asbach, between Allendorf and Zizzendorf; in Dolomite near Pœssneck, Könitz,[1] and Glücksbrunn in Thuringia. According to Beyrich, in Schlesien." Fossils, which Count Münster has identified with the present species, occur in the Trias (?) rocks of St. Kassian.

BAKEVELLIA ANTIQUA, *Münster*, Plate XIV. figs. 28, 29, 30, 31, 32, 33, 34.

AVICULA ANTIQUA, *Münster*. Goldfuss, Petrefacta, part ii, p. 126, pl. cxvi, fig. 7 *a*, *b*.
(?) A SPECIES OF AVICULA,[2] *Murchison*. Silurian System, p. 50, 1839.
AVICULA INFLATA, *Brown*. Trans. Manch. Geol. Soc., vol. i, p. 65, pl. vi, figs. 25, 26, 1841.
— BINNEYI „ Op. cit., p. 65, pl. vi, fig. 27.
— DISCORS „ Op. cit., p. 65, pl. vi, fig. 28.
LAST THREE SYNONYMS, *Brown*. Brown's Fossil Conchology, pl. lxvi**, figs. 3-8, 1843
Do. „ Morris, Catalogue, p. 106, 1843.
Do. „ De Verneuil, Bull. Soc. Géol. de France, 2me série, t. i, p. 33, 1844.
AVICULA ANTIQUA, *Münst.* Loc. cit.
— — „ Geol. Russ., vol. i, p. 224; vol. ii, pp. 319-20, pl. xx, fig. 13 *a*, *b*, 1845.
CAPT. BROWN'S THREE SYNONYMS. Loc. cit.
AVICULA ANTIQUA, *Münst.* Keyserling, Petschora-land, p. 250, 1846.
— — „ Tennant, Strat. List, p. 88, 1847.
CAPT. BROWN'S THREE SYNONYMS. Loc. cit.
BAKEVELLIA ANTIQUA, *Münster*. King, Catalogue, p. 10, 1848.
AVICULA — „ Howse, Trans., T. N. F. C., vol. i, p. 249, 1848.
GERVILLIA KERATOPHAGA, *Schlotheim*. Geinitz, Versteinerungen, p. 10 (*? partim*), 1848.

[1] I collected specimens of *Bakevellia ceratophaga* at Schlossberg von Könitz.

[2] "A species of Avicula not very remote from the *A. socialis* of Schl. occurs in the Magnesian Marls at Collyhurst, near Manchester." (Op. cit.)

Diagnosis.—"Shell subrhomboidal, arched, smooth; front wing acute, hinder one obtuse angulate."[1] (Münster.)

Probably Count Münster drew up the above diagnosis from a smooth variety, or a specimen divested of its testaceous covering,—a rather common case; as this species is quite as much striated as the last.

Dr. Geinitz has merged *Bakevellia antiqua* into *B. ceratophaga;* but there is clearly sufficient difference between them to warrant their separation. The present species differs from *B. ceratophaga* in being a more tumid shell; in having the valves thicker, the umbones more divaricated, the hinge-areas larger, the sinus in the wing-areas much smaller, the wing less produced, the byssal or pedal sinus only slightly marked, the incremental striæ more regular, and the anterior lobes and wing-areas decidedly less obviously separated from the convexity of the valves. It also attains a larger size. My largest specimen is an inch and a quarter in width, that is, in the direction of the hinge, and seven eighths of an inch in length.

Owing to the thickness of the valves of *Bakevellia antiqua*, the muscular impressions are so strongly marked, that casts occasionally display them in the most instructive manner. The cast represented in Pl. XIV, fig. 33, particularly enabled me to decide that the species had no relation to the genus in which it had usually been placed: the anterior and posterior adductor muscular impressions (*a*, *b*) and the pallial line (*c*) are so well marked, that there can be no doubt of its being a true Dimyarian.

Notwithstanding the thickness of the valves, both are strengthened internally on the anterior side of the umbonal cavity with a slight ridge, which posteriorly bounds the anterior adductor muscular impression.

Bakevellia antiqua has some resemblance to young specimens of the Carboniferous *Gervillia lunulata*, Phillips. It is in some localities a rather variable species, particularly in the neighbourhood of Manchester, where specimens occur varying much in the divarication of the umbones. Captain Brown has been led to regard these varieties, from an examination of some imperfect and in many cases distorted casts, as different species; but I feel persuaded, after carefully examining the original specimens, including others contained in various collections, that they are all referable to the present species.

Bakevellia antiqua is a widely distributed species, and appears to be characteristic of every member of the Permian system. It occurs in the Shell-limestone of Humbleton Quarry, Hylton North-Farm, Southwick-lane House, Dalton-le-Dale, Ryhope Field-House Farm, Tunstall Hill, Silksworth, and Castle Eden-Dene; in the probably contemporaneous Breccia at the north end of Black Hall Rocks; and in the lowest beds of Whitley Quarry. It is found in the Permian Marls at Bedford, Collyhurst, and Newtown near Manchester (Binney); also at Woodhall, Stubbs Hill,

[1] "Avicula testa subrhomboidali fornicata lævi, ala antica acuta postica obtusangula." (Goldfuss, Petrefacta, 2d part, p. 126.)

Collywesten, and between Mar and Hickleton. Mr. Binney has collected specimens at Hampole, in Yorkshire, and at Kirkby Woodhouse, Notts. Count Münster records its occurrence at Glücksbrunn; and it is probably found at most of the other German localities noticed under the last species. M. de Verneuil has procured it in the Permian rocks of Tioplova, Kliutziski, Pinega, Itschalki, and Barnoukova, in Russia; and in the Carboniferous deposits at Mala, Jaroslavetz, and near Vitegra. Count Keyserling found specimens in the Permian Limestone on the Wytschegda, near Ust-Nem, and on the Wymm, in Petschora-land. Count Münster records its occurrence in the Trias (?) Marls of St. Kassian.

BAKEVELLIA TUMIDA, *King*. Plate XIV, figs. 35, 36, 37.

(?) SMALL SPECIES OF MODIOLA, *J. de C. Sow.* Trans. Geol. Soc. Lond., 2d series, vol. iii, p. 119, 1829.
GERVILLIA (?) TUMIDA, *King*. De Verneuil, Bull. Soc. Géol. de France, 2me série, t. i, p. 33, 1844.
— — ,, Geol. Russ., vol. i, p. 225, 1845.
— — ,, Tennant, Strat. List, p. 88, 1847.
BAKEVELLIA — ,, Catalogue, p. 10, 1848.
AVICULA INFLATA, *Brown*. Howse, Trans. T. N. F. C., vol. i, p. 250, 1848.

Diagnosis.—Modioliform: longer than wide, the length being half an inch, and the width a quarter. *Valves* convex; (?) smooth. *Umbones* divaricated; slightly incurved. *Anterior lobes* distinct. *Posterior wings* very slightly produced. *Hinge-areas* large; with four or five cartilage-pits. *Byssal or pedal sinus* rather large in the under valve.

This is a well-marked shell, easily distinguished from the former two species, even the most tumid variety (= *Avicula inflata*, Brown) of *Bakevellia antiqua*, in being longer than wide, and in the greater divarication of the umbones. It also appears to be a smaller species.

Bakevellia tumida occurs rarely at Tunstall Hill and Dalton-le-Dale, and rather commonly at Humbleton Quarry and Ryhope Field-House Farm, in Shell-limestone.

BAKEVELLIA BICARINATA, *King*. Plate XIV, figs. 41, 42.

BAKEVELLIA BICARINATA, *King*. Catalogue, p. 10, 1848.

Diagnosis.—"Nearly smooth, winged, and furnished with two faint ridges on its anterior lobes." (King.)

This species, which I have elsewhere supposed to be a variety of one of the former species, is somewhat intermediate in form to *Bakevellia ceratophaga* and *Bakevellia antiqua;* though evidently more related to the former.[1] Its ridges diverge (vide

[1] Catalogue, p. 10. A mistake was made in stating that *Bakevellia bicarinata* "may be a variety of *B. antiqua*: *B. ceratophaga* was intended for the last species.

Pl. XIV, fig. 42); and, although stated to be a "nearly smooth" species, it is seen, when examined by a common magnifier, to be prettily ornamented with very fine raised lines.

It occurs in the Shell-limestone of Tunstall Hill, where it is very rare.

BAKEVELLIA SEDGWICKIANA, *King*. Plate XIV, figs. 38, 39, 40.

BAKEVELLIA SEDGWICKIANA, *King*. Catalogue, pp. 10, 11, 1848.

Diagnosis.—Outline "somewhat acutely rhomboidal; smooth; pointed in front; and scarcely winged." (King.)

The anterior and posterior margins of this species are remarkably oblique to its cardinal line, which is caused by the slight development of the posterior part of the hinge and the anterior lobe, together with the opposite or posterio-ventral portion of the valves, being very much produced. It is much flatter than any of the previously noticed species. The specimen represented by fig. 39, Pl. XIV, is supposed to be the small or under valve.

Bakevellia Sedgwickiana is found, but rarely, in the Shell-limestone of Tunstall Hill.

Family ARCIDÆ (*Arches*), Cuvier, 1800.

Diagnosis.—Valves variable in outline, according to genera. *Hinge* straight; furnished often its entire length with numerous interlocking teeth. *Cartilage* external; generally divided; and situated on an area between the umbones.

The family is here restricted to the true or areagerous genera.

Genus *Byssoarca*, Swainson, 1820.

Diagnosis.—Inequilateral: equivalved: generally wider than long. *Ventral margins* sinuated for the passage of a byssus.

Type *Arca Noæ*, Linnæus.

As the first species, which the author of the *Systema Naturæ* described under his group *Arca*, is the *A. tortuosa*, it follows that this singularly-formed shell must be considered as the type of the Linnean genus: this circumstance renders imperative our adopting Swainson's genus *Byssoarca*, which is typified with the *Arca Noæ*, and which, in the absence of the original diagnosis, I have made free in characterising as above. It is distinguished from *Arca* in its regular form, approximating, by means of this character, to the regularly-formed, inequivalved, non-byssiferous *Arcidæ*—those represented by the *Arca antiquata* of Linnæus. Several genera of *Arcidæ*, such as *Litharca*, *Senilia*, *Trisis*, *Barbatia*, and others, have been proposed, some of which probably embrace the last-named species; but being unacquainted with their type, it s impossible for me to proceed further with a comparative view of the present genus.

BYSSOARCA STRIATA, *Schlotheim*. Plate XV, figs. 7, 8, 9.

MYTILITES STRIATUS, *Schl.* Münch. Akad., vol. vi, p. 31, pl. vi, fig. 3 *a, b, c*, 1816.
— — „ Petrefactenkunde, p. 298, 1820.
— — „ Boué, Edin. Phil. Journal, vol. xii, p. 144, 1825.
CUCULLÆA, N. S., *Phillips*. Phil. Mag., vol. iv, p. 401, 1828.
— SULCATA, *J. de C. Sow.* Trans. Geol. Soc. Lond., 2d series, vol. iii, p. 119, 1829.
— — „ De la Beche, Geol. Man., p. 384, 1831; Germ. Transl., p. 459, 1832; 3d Eng. ed., p. 573, 1833.
MYTILUS STRIATUS, *Schl.* Op. cit., Germ. Transl., p. 459, 1832; 3d Eng. ed., p. 573, 1833.
— — „ Phillips, Encyc. Met., vol. iv, p. 616, 1834.
CUCULLÆA SULCATA, *J. de C. Sow.* Loc. cit.
— — „ Thomson, Outlines of Geology, &c., vol. ii, p. 314, 1836.
ARCA ANTIQUA, *Münster*. Goldfuss, Petrefacta, 2d part, p. 145, pl. 122, fig. 8.
CUCULLÆA SULCATA, *J. de C. Sow.* Morris, Catalogue, p. 85, 1843.
ARCA ANTIQUA, *Münster*. Geinitz, Gæa von Sachsen, p. 95, 1843.
— — „ De Verneuil, Bull. Soc. Géol. de France, 2me série, vol. i, p. 32, 1844.
— — „ Geol. Russ., vol. i, p. 224, 1845.
BYSSOARCA TUMIDA, *J. de C. Sow.* (*partim*). King, Catalogue, p. 11, 1848.
ARCA LOFTUSIANA, *Howse*. Trans. T. N. F, C., vol. i, pp. 246, 247, 1848.
(?) — TUMIDA, *J. de C. Sow.* Geinitz, Versteinerungen, p. 9, pl. iv, fig. 7, 1849.

Diagnosis.—"Shell ovato-trapezoidal, ventricose, the umbones intermedian and distant, the underside sub-compressedly declining, marked with numerous radiating, closely-set, furcated, granulated lines."[1] (Münster.)

This species, which has been variously named by Schlotheim, J. de C. Sowerby, and Münster, was considered in my 'Catalogue' as a variety of *Byssoarca tumida*,—the fossil next to be considered. It is certainly the *Cucullæa sulcata* of J. de C. Sowerby; as I have seen a specimen thus named in the collection of this gentleman.

Those who contend for its distinctiveness, compared with *Byssoarca tumida*, may dwell on its greater width, more approximate umbones, and less rounded ventral margins; it cannot be denied, however, that specimens occur apparently militating against their being specifically separated.

The specimen represented by Count Münster, in the 'Petrefacta,' has the ribs slender, divided toward the ventral margins, and finely granulated or nodulous; but specimens occurring at Humbleton and Tunstall Hills have generally the ribs simple, somewhat stronger, and rather more coarsely nodulous.

This species has only anterior and posterior teeth, which are nearly parallel to the

[1] "Arca testa ovato-trapezoidea ventricosa, umbonibus antemedianis et distantibus, latere postico sub-compresso-declivi, lineis radiantibus crebris confertis furcatus granulatis." (Goldfuss's Petrefacta, 2d part, p. 145.

hinge-line, as those of *Cucullæa* (vide Pl. XV, fig. 8), and finely sulcated. It was the former character that led Mr. J. de C. Sowerby to place it in the genus just named.

Byssoarca striata occurs at Tunstall Hill and Humbleton Quarry, in Shell-limestone. Professor Phillips appears to have discovered it at Ferry Bridge. Dr. Geinitz records its occurrence in the under Zechstein of Corbusen, near Ronneburg; and in the Zechstein-dolomite of Pœssneck, Glücksbrunn, and at Wartberg, near Seebach, in Thuringia.

BYSSOARCA TUMIDA, *J. Sowerby*. Plate XV, figs. 1, 2, 3, 4, 5.

ARCA ANTIQUATA, *Linn.*	J. B. Taylor, Surtees's Durham, vol. i, p. 249, 1816.
CASTS OF ARCÆ, *Winch.*	Trans. Geol. Soc. Lond., vol. iv, p. 10, 1817.
— — ,,	Conybeare and Phillips's Geology, p. 305, 1822.
ARCA TUMIDA, *J. Sowerby*.	Mineral Conchology, vol. v, p. 116, pl. 474, fig. 3.
— — ,,	Fleming, Brit. Animals, p. 399, 1828.
— — ,,	Sedgwick, Trans. Geol. Soc. Lond., 2d series, vol. iii, p. 119, 1829.
— — ,,	De la Beche, Geol. Man., p. 384, 1831; Germ. Transl. p. 459, 1832; 3d Eng. ed., p. 573, 1833.
— — ,,	Phillips, Encyc. Met., vol. iv, p. 616, 1834.
— — ,,	Thomson, Outlines of Mineralogy, &c., vol. ii, p. 314, 1836.
— — ,,	Morris, Catalogue, p. 78, 1843.
— — ,,	De Verneuil, Bull. Soc. Géol. de France, 2^{me} série, vol. i, p. 32, 1844.
— — ,,	Geol. Russ., vol. i, p. 224, 1845.
— — ,,	Tennant, Strat. List, p. 88, 1847.
BYSSOARCA TUMIDA, *J. Sow.*	King, Catalogue, p. 11, 1848.
ARCA — ,,	Howse, Trans. T. N. F. C., vol. i, p. 247, 1848.

Diagnosis.—"Transversely elongated, gibbose, costated (?); anterior side pointed; marginal sinus short, deep; beaks distant." (J. Sowerby.)

Byssoarca tumida differs from the last species principally in being more tumid, shorter transversely, and more rounded at the ventral margin. In general the ribs (which were only slightly indicated on the cast examined by Mr. Sowerby) are simple; but occasionally specimens occur in which they are distinctly divided: they are more or less granulated or nodulous: those posteriorly situated are generally so; the anterior and median, only occasionally. Sometimes specimens occur with the valves beautifully decussated, arising from the ribs and intervening furrows being crossed with rather prominent incremental lamellæ. The cartilage-grooves on the areas are very fine, and uniangulated under the umbones (vide Pl. XV, figs. 2, 3). The byssal opening is rather large (fig. 5).

This species appears to have had a wider range than the last, being found at Humbleton Quarry, Hylton North Farm, Tunstall Hill, Dalton-le-Dale, and Ryhope Field-House Farm, in Shell-limestone, and somewhat common. Having referred the specimen figured by Geinitz in the 'Versteinerungen' with a doubt to *Byssoarca striata*,

though it might, with equal propriety, have been doubtingly referred to the present species, it follows that I am quite disposed to extend its range to the Permian region of Germany.

Byssoarca Kingiana, *De Verneuil.* Plate XV, figs. 10, 11, 12.

Arca Kingiana, *De Verneuil.*		,,	Bull. Soc. Géol. de France, 2me série, vol. i, p. 32, 1844.
—	—	,,	Geol. Russ., vol. i, p. 224; vol. ii, p. 313, pl. xix, fig. 11, 1845.
Byssoarca Kingiana		,,	King, Catalogue, p. 11, 1848.
Arca	—	,,	Howse, Trans. T. N. F. C., vol. i, p. 247, 1848.
—	—	,,	Geinitz, Versteinerungen, p. 9, pl. iv, fig. 8 *a*, *b*, *c*, 1848.

Diagnosis.—"Shell inequilateral, oval, transverse, twice as wide as it is long, and truncated obliquely at its posterior extremity. *Umbones* projecting, situated near the anterior extremity, which is round. *Cardinal margin* straight, terminated posteriorly by an obtuse angle; with a narrow, triangular, depressed area between the back and the cardinal margin. The valves apparently smooth externally."[1] (De Verneuil.)

Byssoarca Kingiana, for the name of which I feel highly complimented by M. de Verneuil, who first described it, is very distinct from the foregoing species, although, in one respect, not to the extent implied by the original diagnosis; since the valves, instead of being smooth externally, as suspected by De Verneuil, are marked with rather distant, slightly raised, occasionally dichotomous lines diverging from the umbones: these lines might be considered as an incipient form of the ribs characteristic of *Byssoarca striata* and *B. tumida*. It cannot, however, be confounded with either species; as its areas are much narrower, being, in fact, only slightly developed; its umbones more obtuse; its dorsal slopes less impressed; and its byssal sinuses smaller. Besides, it does not appear to attain so large a size: my largest specimen is an inch in width, and half an inch in length.

This species is much scarcer than its associated congeners; but it is more widely diffused. I have found it only, and very seldom, at Tunstall Hill, in Shell-limestone. Dr. Geinitz notices the single German locality,—Könitz, in Zechstein-dolomite. M. de Verneuil discovered it in the Iltchegulova limestones, forming the base of the Permian system, in the valley of the Dioma, government of Orenburg, Russia; and Count Keyserling records its occurrence on the Wymm, in Petschora-land.

Family Nuculidæ, King.

The members of this group have hitherto been placed in *Arcidæ;* but both their shell and mollusk possess characters clearly diagnostic of a distinct family. *Arcidæ* and *Nuculidæ* appear, in short, to be only approximately allied: it must not be over-

[1] Geology of Russia, vol. ii, p. 313.

looked, however, that both families may have been much more closely connected by means of palæozoic forms, than they appear to be by such as are now living. The mollusks of the various genera of *Nuculidæ* differ remarkably from each other in their structure, perhaps more so than in any other known family; since in *Leda*, *Yoldia*, and *Solenella* their mantle is closed posteriorly, and furnished with an ingress and an egress siphon; whereas in *Nucula*, the mantle is entirely open, and unprovided with these appendages. These differences are indicated in the shells—for example, by the presence of a sinuated pallial line in the former, and an entire pallial line in the latter. Probably *Leda* and *Nucula* graduate into each other; as a species shortly to be noticed, strictly speaking, is neither of one genus nor the other. The shells of *Nuculidæ*, although agreeing with those of *Arcidæ* in their dental system, differ in having an arcuated hinge-line, and an internal cartilage confined to a more or less projecting callosity. While *Nuculidæ*, as regards the cartilage-fulcra, is seemingly allied to certain genera of the first section of De Blainville's *Pyloridés*, *Arcidæ* is undoubtedly related to the Monomyarians and certain Dimyarians, as *Mytilidæ* and *Bakevelliidæ*, which have the cartilage more or less expanded over the hinge-plates.

The two following genera are all that are known as Permian.

Genus *Nucula*, Lamarck.

Diagnosis.—"Shell equivalve, inequilateral, shortened anteriorly, ovato-trigonal or obliquely ovate, closed, smooth, or concentrically striated, or (in certain exotic and fossil species) marked by zig-zag or radiating furrows; always invested with a smooth epidermis; margin denticulated or smooth; backs approximated, incurved; inside nacreous: hinge-line angulated, a ligamental fossette at the angle, and a range of comb-like, small, sharp teeth on each side; ligament chiefly internal; pallial impression entire."[1]

Nucula Tateiana,[2] *King.*

Diagnosis.—Wedge-shaped: smooth: very inequilateral: anterior margin shorter than the posterior, and at right angles to the dorsal line: half an inch in width. *Umbones* moderately tumid. *Hinge-line* acutely angulated; with five anterior and nine posterior teeth.

During my last visit to Humbleton Hill, and after my plates were engraved, I was rewarded by the discovery of a single impression of the dorsal half of a true *Nucula*. From a gutta-percha cast taken of this impression, I have been enabled to draw up the above incomplete diagnosis, which I must leave to be more fully worked out by others.

[1] Forbes and Hanley, British Mollusca, vol. ii, pp. 214-15.

[2] Named after my esteemed friend, Mr. George Tate, F.G.S., of Alnwick.

Nucula Tateiana is with difficulty distinguished from the *N. gibbosa*, Fleming, of the Carboniferous system: the former, however, differs from the latter in its anterior and posterior slopes being more inclined, and its umbones less tumid. From the Permian and Petschorian *N. Wymmensis*, Keyserling, it differs in being nearly, or perhaps entirely, smooth, and not so compressed.

Habitat: Humbleton Quarry, in Shell-limestone.

Genus *Leda*, Schumacher.

Diagnosis.—"Shell equivalve, inequilateral, oblong, produced posteriorly, closed, smooth, or concentrically striated, invested by an epidermis; margins smooth; beaks approximated, incurved; inside more or less nacreous; hinge-line angulated, and formed, as well as the ligament, as in *Nucula*. Pallial impression with a sinus."[1]

Leda Vinti,[2] King. Plate XV, figs. 21, 22.

Nucula Vinti, *King*.			De Verneuil, Bull. Soc. Géol. de France, 2me série, vol. i, p. 32, 1844.
—	—	„	Geol. Russ., vol. i, p. 224, 1845.
—	—	„	Tennant, Strat. List, p. 88, 1847.
Leda	—	„	King, Catalogue, p. 11, 1848.
—	—	„	Howse, Trans. T. N. F. C., vol. i, p. 248, 1848.
Nucula speluncaria, *Geinitz*.			Versteinerungen, p. 9, pl. iv, fig. 6 *a*, *b*, 1848.

Diagnosis.—"*Form* a little inequilateral: *anterior end* the shortest, and rounded: *posterior end* attenuated, and rounded at the extremity: *umbones* rather tumid, and turned posteriorly: *surface* marked with slightly waved, prominent, transverse lines, which suddenly become nearly obsolete on the posterior third of the valves: *pallial sinus* very small."[3]

The form of this elegant species indicates its generic position more than the character of its pallial line, which appears to be scarcely sinuated (Vide Pl. XV, fig. 22). It closely resembles the Muschelkalk *Leda excavata* (*Nucula id.*) of Goldfuss, and appears to have some similarity to the imperfectly-known Permian *Leda Kazanensis* (*Nucula id.*) of De Verneuil. *Leda parunculus* (*Nucula id.*), Keyserling, is another allied shell, which is, however, more inequilateral than the present species. My largest specimen measures three quarters of an inch in width.

Well-marked casts exhibit a faint but broad furrow (in the shell a ridge) running

[1] Forbes and Hanley, British Mollusca, vol. ii, p. 226.

[2] Named after Mr. Robert Vint, of Sunderland, whose assistance in my early studies merits my warmest acknowledgments.

[3] King, Catalogue, p. 11.

from each umbone to the pallial line, at the same time curving slightly towards the posterior end. (Vide Pl. XV, fig. 22.)

Leda Vinti, which is a rare species, occurs in the lowest beds of Whitley and Humbleton Quarries, and in both the compact and crystallized rocks near Byers's Quarry. According to Geinitz, M. Mielecki has discovered it in the Zechstein-dolomite of Katzenstein, in the Hartz.

Family Solemyidæ, Philippi.

"The very singular *Solenomyæ* ought to constitute a family of themselves, the gills not being lamellate, but twice pectinate or pinnate: the mantle is closed, attached to the whole of the shell, not reflexed at the ventral margin: siphons none, the aperture for the anal excretions, and for the branchial water being undivided. Epidermis shining, reaching beyond the margin, and elegantly slashed; not of a horny substance, for, when treated with caustic potash, it does not exhale ammonia, but seems rather of a glutinous nature."[1] (Philippi.)

This very singular family has now existed during an immense lapse of time on our planet. Professor Phillips, by his discovery of the so-called *Solemya primæva*, was the first to make known its having lived during the Carboniferous epoch. I have elsewhere noticed my discovery of species belonging to the Devonian rocks of the Eifel, and to the Magnesian-limestone formation of Durham.[2] I am not acquainted with any secondary or tertiary forms; but their having existed during the primary period, and their being now wide-spread denizens of our seas, are, in my estimation, positive proofs of the family having lived during the intermediate periods. The recent *Solemya* and the palæozoic *Janeia* are the only genera known belonging to the group.

Genus *Janeia*, King.

Diagnosis.—Oblong: inequilateral, the posterior side being the longest. *Cartilage* internal; attached to a considerable portion of, and a little within, the dorsal margin of the valves; dilated, and somewhat oval within the umbonal cavity; narrow, and elongated behind it.[3]

Type, *Solemya primæva*, Phillips.

[1] Enumeratio Molluscorum Siciliæ, p. 15.

[2] London Geological Journal, vol. i, p. 10.

[3] For further remarks on this genus, see Appendix.

JANEIA BIARMICA, *De Verneuil.* Plate XVI, fig. 7.

SOLEMYA BIARMICA, *De Verneuil.* Bull. Soc. Géol. de France, 2me série, vol. i, p. 30, 1844.
— — ,, Geol. Russ., vol. i, p. 223; vol. ii, p. 294, pl. xix, fig. 4 *a*, *b*, 1845.
— — ,, Keyserling, Petschora-land, p. 259, 1846.
(?) — — ,, King, Catalogue, p. 11, 1848.
SOLENIMYA ABNORMIS, *Howse.* Trans. T. N. F. C., vol. i, p. 244, 1848.
SOLEMYA BIARMICA, *De Vern.* Geinitz, Versteinerungen, p. 8, pl. iii, fig. 34 *a*, *b*, 1848.

Diagnosis.—"Transverse, very inequilateral, and gaping at its extremities." "The posterior side is much longer than the anterior one:" it is also "wider, and more rounded."[1] (De Verneuil.)

I regret that my specimens of this interesting shell are so imperfect, as to prevent my adding much to the provisional description given of it by M. de Verneuil. The specimen figured in the 'Geology of Russia,' pl. xix, fig. 4, is an internal cast, and smooth, which is probably the character of the external surface of the valves, with the exception of some rather obscure wrinkles running parallel to the free margins, as in the testiferous specimen represented in Pl. XVI, fig. 7: the posterio-ventral margin of the valves appears to slope upwards, that is, posterio-dorsally. The specimen just cited is a simple valve, I am therefore unable to say whether or not it agrees with the one figured by De Verneuil, in being open at the extremities. The description given by Geinitz of the specimen figured in the 'Versteinerungen' is quite applicable to those occurring in England.

Janeia biarmica is a rare fossil, and has only occurred to me at Tunstall Hill and Humbleton Quarry. M. de Verneuil found it in the limestones, associated with gypsum, forming the base of the Permian system at Kniazpavlova, government of Nijni-Novgorod: some badly-preserved specimens, referred with doubt to the same species, were found by this author at Gorodok, on the Tchusovaya, and in the valley of Karla near Nijni-Troisk, in the district of Bielebei. Count Keyserling states that it occurs in the Permian Limestone on the Wel near Kischerma, in Petschora-land. According to Geinitz, M. Spengler discovered a specimen (the one figured in the 'Versteinerungen') in the Kupferschiefer of Kamsdorf. I possess a specimen of a *Janeia* from the Mountain-limestone of Redesdale, Northumberland, apparently undistinguishable from the present species.

[1] Geol. Russ., vol. ii, p. 294. The terms *anterior* and *posterior*, in the above, are conversely applied to what they are in the original diagnosis.

JANEIA PHILLIPSIANA,[1] *King*. Plate XVI, fig. 8.

MAGNESIAN LIMESTONE SOLEMYA, resembling *S. primæva, King*. London Geological Journal, vol. i, p. 10, 1846.

SOLEMYA PHILLIPSIANA, *King*. Catalogue, p. 11, 1848.

SOLENIMYA NORMALIS, *Howse*. Trans. T. N. F. C., vol. i, p. 244, 1848.

Diagnosis.—Valves compressed; marked with a few rather distant, slightly raised bands radiating from the umbones towards the posterio-ventral margin; with the posterior border of the anterior adductor muscular impressions corresponding with a line drawn vertically from the umbone to the ventral margin.[2]

This is a more compressed species than *Janeia biarmica;* and it is further distinguished by being marked externally with flat, slightly raised, spreading bands, rather distant from each other. It has the posterior border of the anterior adductor muscular impressions perpendicular (vide Pl. XVI, fig. 8), which is different to what prevails in *Janeia primæva*, and *Solemya Mediterranea*, in which this part is oblique.

Janeia Phillipsiana is a rare species in the Shell-limestone of Humbleton Quarry.

Family CARDITIDÆ (*Les Cardites*), Cuvier.

The present group embraces *Cardita, Carditamera*, and some other existing genera: also *Pleurophorus*, and it is suspected *Cardiomorpha*, as well as a few more extinct co-ordinate groups.

Genus *Cardiomorpha*, De Koninck.

Diagnosis.—"Shell equivalved: inequilateral: thin: generally oblique or transversely elongated. *Hinge* linear; without teeth. *Cardinal plates* smooth; prolonged from the umbones to the extremity of the cardinal margin. *Ligament* linear; external. *Umbones* recurved. Muscular impressions two, joined by a simple pallial line." (De Koninck.[3])

Type, *Cardiomorpha elongata*, De Koninck.

This genus, although edentulous, appears to be a member of *Carditidæ;* inasmuch as it possesses the muscular impressions, cartilage fulcra, and transversely elongated form characteristic of the family. It often resembles *Modiola;* but it differs therefrom in having an external cartilage, which, together with an edentulous hinge, and an entire pallial line, appear to be its chief distinctive characters.

[1] Named in commemoration of Professor Phillips being the first discoverer of a fossil Solemyidia—the carboniferous *Janeia primæva*.

[2] King, Catalogue, p. 11.

[3] Description des Animaux fossiles qui se trouvent dans le terrain carbonifère de Belgique, p. 101. "Testa æquivalvis, inæquilatera, tenuis, plerumque oblique vel transversim elongata. Cardo linearis, edentulus. Lamina cardinalis glabra; ab umbonibus ad extremitatem marginis cardinalis producta. Ligamentum lineare, externum. Umbones recurvi. Impressiones muscularis duæ, impressione palleali simplici conjunctæ."

CARDIOMORPHA MODIOLIFORMIS, *King*. Plate XIV, figs. 18, 19, 20, 21, 22, 23.

PLEUROPHORUS MODIOLIFORMIS, *King*.			De Verneuil, Bull. Soc. Géol. de France, 2me série, t. i, p. 32, 1844.
—	—	,,	Geol. Russ., vol. i, p. 224, 1845.
CARDIOMORPHA	—	,,	King, Catalogue, p. 10, 1848.
MYOCONCHA	—	,,	Howse, Trans. T. N. F. C., vol. i, p. 245, 1848.

Diagnosis.—Modioliform: tumid diagonally in the umbonal region, and compressed towards the margins: measuring three quarters of an inch from the point of the umbones to the posterio-ventral margin: marked with rather distant lines radiating from the umbones posteriorly, the lines being raised in young individuals, and impressed in old ones. *Umbones* incurved. *Lunette* heart-shaped. *Corselet* long, rather shallow, defined by a rather prominent ridge, which curves in both valves from the point of the umbone to the termination of the hinge. *Anterior muscular impressions* bounded posteriorly by a slightly elevated ridge.

Cardiomorpha modioliformis, in its marginal outline, bears a resemblance to some varieties of *Cardiomorpha Pallasi* (*Mytilus id.*[1]), De Verneuil; but it is a shorter and a more tumid species; and its umbones are more incurved: in the latter character, and in being diagonally tumid, it approximates to *Cypricardia glabrata*, Phillips,—a species, which, had it occurred in the Permian rocks instead of the Carboniferous, I might have considered identical with the present one. It has very much the aspect of a *Modiola*, particularly one variety, which is distinctly lobed in front (vide Pl. XIV, figs. 20, 23). Old specimens occasionally become diagonally carinated like *Cypricardia rhombea*, Phillips (vide Pl. XIV, fig. 21). The specimen represented by the figure last cited, the largest one I have procured, is upwards of an inch in width.

It occurs, but rarely, in the Shell-limestone of Tunstall Hill, Ryhope Field-House-Farm, and Humbleton Quarry.

Genus *Pleurophorus*, King, 1848.

Diagnosis.—"*Form* inequilateral: *cartilage* external: *anterior adductor muscular impressions* deeply excavated, often bounded posteriorly by a ridge: *pallial line* entire: *dentition* cardinal and posterior: *cardinal teeth* two in each valve, diverging inwardly, and interlocking alternately: *posterior teeth* linear; the receiving tooth in the left valve." (King.[2])

Type, *Arca costata*, Brown.

[1] A specimen of this species, kindly given me by M. de Verneuil, clearly exhibits the external position of the cartilage fulcra, a character which has not been overlooked by its founder (vide Geol. Russ., vol. ii, p. 316): it is therefore clearly neither a *Mytilus* nor a *Modiola*.

[2] Catalogue, p. 11.

The species just named, and which has afforded the above diagnosis, agrees very closely in its dentition with the so-called *Cardita crenata* of Goldfuss (vide 'Petrefacta,' pl. 133, fig. 6), judging from a specimen in my cabinet collected at St. Kassian in the Tyrol. I am consequently induced to regard the latter as belonging to the genus under consideration. Neither species can be placed in *Cardita*; as this genus has the upper cardinal tooth of the right valve very much elongated posteriorly, so as to occupy the entire space below the cartilage fulcrum; and it is without any posterior teeth: on the other hand, *Pleurophorus* has the corresponding cardinal tooth ordinarily short; and it possesses true posterior teeth: in both genera, it requires to be observed, the cardinal dental *formula* is the same. *Cypricardia* might be adduced as an allied genus, from its possessing posterior teeth; but the receiving tooth is in the right valve, and it has strong anterior teeth in addition: the same difference prevails in *Pachyodon*. The recently formed genus *Carditamera*, typified with the *Cardita affinis*, agrees with *Pleurophorus* in possessing similarly arranged posterior teeth; but it has the upper cardinal tooth of the right valve of the same elongated form as that of *Cardita*: it also possesses anterior teeth. *Coralliophaga*—a genus which some might consider as synonymous with *Pleurophorus*—differs in having a sinus in the pallial line. The genus *Myoconcha*, placed by Mr. J. E. Gray in the present family,[1] may have a relation to *Pleurophorus*: they differ, however, in their dental system; since the former (which is founded on the Oolitic *M. crassa*) is described by Mr. Sowerby, as having "an external ligament, and *one* oblique elongated (cardinal) tooth in the left valve; impressions of the mantle not sinuated," and "*no lateral teeth.*"[2]

PLEURophorus costatus, *Brown*. Plate XV, figs. 13, 14, 15, 16, 17, 18, 19, 20.

ARCA COSTATA, *Brown*. Trans. Manch. Geol. Soc., vol. i, p. 32, pl. vi, figs. 34, 35, 1841.
— — „ Brown's Fossil Conchology, pl. lxxvii, figs. 31, 32, 1843 (?).
— — „ Morris, Catalogue, p. 78, 1843.
MODIOLA COSTATA, *Brown*. De Verneuil, Bull. Soc. Géol. de France, 2me série, t. i, p. 32, 1844.
— — „ Geol. Russ., vol. i, p. 224, 1845.
CYPRICARDIA MURCHISONI, *Geinitz*. Grundriss, p. 434, pl. xix, fig. 2, 1846.
(?) MODIOLA SIMPLA, *Keyserling*. Petschora-land, p. 260, pl. x, fig. 22, pl. xiv, fig. 1, 1846.
— COSTATA, *Brown*. Tennant, Strat. List, p. 88, 1847.
PLEUROPHORUS COSTATUS, *Brown*. King, Catalogue, p. 11, 1848.
MYOCONCHA COSTATA „ Howse, Trans. T. N. F. C., vol. i, p. 245, 1848.
CARDITA MURCHISONI, *Geinitz*. Versteinerungen, p. 9, pl. iv, figs. 1-5, 1848.

Diagnosis.—"Shell transverse, oblong-ovate; posterior (anterior, *nobis*) slope exceedingly short; anterior (posterior, *nobis*) slope very long; umbones small, and but slightly produced; both valves provided with three prominent ribs, emanating

[1] Synopsis of the British Museum, p. 128, 1841.
[2] Mineral Conchology, vol. v, p. 103.

from the umbones, and diverging towards the superior (ventral or inferior, *nobis*) portion of the anterior (posterior, *nobis*) slope; whole shell covered with irregular, nearly obsolete, concentric wrinkles. Length five sixteenths of an inch; breadth upwards of half an inch."[1] (Brown.)

Pleurophorus costatus is a remarkably inequilateral species, the umbones being close to its anterior end: its dorsal and ventral margins are nearly parallel to each other; and the lateral terminations are obtusely rounded: it has generally three or four, occasionally six, rather sharp ribs running from the umbones to the posterio-ventral margin; and is furnished with a long corselet extending nearly the entire length of the back, and a well-defined lunette. The cartilage-fulcra are short, extending very little behind the umbonal points. The ridge posteriorly bounding the anterior adductor muscular impression, in each valve, is rather prominent, and marked, at its junction with the dental plate, with a small impression, evidently due to one of the visceral or pedal muscles. The dental system is represented in Pl. XV, figs. 16, 17; and the impressions of the adductor muscles and pallial line, in fig. 15, of the same plate. My largest specimen is an inch in width.

A variety occurs at Byers's Quarry, with the valves more tumid, the ribs decidedly less distinct, and the marginal outline more rounded (vide Pl. XV, fig. 20): perhaps it is a distinct species,—a view somewhat supported by the form of a young individual represented in Pl. XV, figs. 18, 19; since small specimens of the normal kind possess the same parallelism of the ventral and dorsal margins as those full grown. Should the so-called variety be hereafter found to constitute a separate species, it is proposed to name it *Pleurophorus ovatus*.

Cypricardia striato-lamellosa, De Koninck, which possesses only two radiating ribs, appears to be a closely allied species: the same may be suggested of the so-called *Nucula cuneata* of Phillips, which differs, however, in being much narrower in front; though some specimens of the present species have a tendency to this form. Dr. Geinitz identifies the present species with De Verneuil's *Modiola Pallasi;* but incorrectly; as the latter has no teeth.

Pleurophorus costatus appears to have had an extensive geographical range. It is a common species at Byers's Quarry, Suter-point, and another locality or two on the coast between Whitburn and Marsden rock: the beds containing it are supposed to be the highest of the Permian series in Durham, and probably equivalent to the German Rauchwacke. Specimens, apparently dwarfed, as they rarely attain half the size of those found in Durham, occur in the Permian Marls at Newtown, near Manchester. A specimen bearing the locality "Stubbs Hill, near Doncaster," is in the collection of the London Geological Society. It likewise occurs, not uncommonly, in the Shell-limestone of Humbleton Quarry, Tunstall Hill, and Silksworth; also, but

[1] Transactions of the Manchester Geological Society, vol. i. p. 32.

more rarely, in the inferior beds at Whitley, Mill-Field Quarry near Bishopwearmouth, and in the Breccia at Tynemouth. I have seen a fossil, apparently undistinguishable from it, found in the Carboniferous shales near Stanhope, in Weardale. Dr. Geinitz gives the following as its German localities: Schwaara, Corbusen, and Ilmthal, in Zechstein; Kamsdorf, in the Flœtz-limestone, between the Weissliegenden and lower Kupferschiefer beds; Könitz, Mühlberg, Landwehr, Katzenstein, Osterode, and Neuhof, in Zechstein-limestone, and Dolomite. I saw, in the mineralogical collection at Kamsdorf, a specimen stated to be from Neustadt. It appears to be also characteristic of the Permian system in Petschora-land; specimens apparently of the same species have been found by Count Keyserling in the Limestone on the Wel near Kischerma, and by M. Schrenk in Marl near Ust-Joschuga on the Pinega.

Family TRIGONIIDÆ (*Les Trigonies*), Cuvier.

Adopting the views of Agassiz, the principal characters of *Trigoniidæ* consist chiefly in the symmetry of the valves, which are regular and perfectly equal, except in the parts composing the hinge: their form is sometimes trigonal, that is, the anterior extremity is truncated or slightly arched, and the dorsal and ventral margins converge backwards in such a manner as to form a rostral prolongation; sometimes squared, that is, truncated posteriorly as well as anteriorly, the upper and under margins being nearly straight: the only existing *Trigonia* is nearly orbicular. The shell is inequilateral, the anterior part being much shorter than the posterior, which is prolonged behind considerably: the umbones in many species are considerably curved inwards, and even strongly arched, contrary to what is generally observed in the acephalous Testacea. The ligament, which forms a strong rounded projection, is external and marginal, attached to the edges of a narrow lunated depression or corselet behind the umbones. The surface of the shell is rarely smooth: its sides are generally ornamented with ribs, tubercles, and varices, variously combined; whilst the corselet, which is generally of considerable extent, and distinctly separated from the sides, is more or less smooth, or presents ornaments which often contrast in a most striking manner with the other parts of the shell: the only living species is uniformly ornamented with transversely pectinated ribs, similar to those of the greater part of the genus *Cardium*. With reference to its dental system; the typical genus of the family has the right valve (vide Pl. XIX, fig. 8, *B*) furnished with two very salient compressed divaricating ridges, sulcated perpendicularly on both sides: the anterior ridge is prolonged towards the anterior margin of the shell (*B*—*b**); whilst the posterior one (*B*—*d**) is directed backwards. There is a small furrow before the anterior ridge, and another behind the posterior one (*B*—*a**, *c**). From the disposition of the ridges and furrows of the right valve, there results an inverse arrangement of certain parts of the left or opposite valve (*A*); while, at the same time, the disposition of other parts is symmetrical: thus, in the centre of the hinge of the latter valve there is a large triangular projection (*A*—*c*),

which is hollowed out on its free side, perpendicularly sulcated on its anterior and posterior sides, and which fits exactly into the triangular space between the two divaricating ridges of the right valve (*B*—*c**). On each side of the central triangular projection there are two deep furrows (*A*—*b*, *d*), which respectively receive each of the two large ridges of the right valve: the anterior one is bordered in front by a small ridge (*A*—*a*), sulcated on its posterior side, and corresponding to the small furrow in advance of the anterior large ridge of the right valve (*B*—*a**); and the posterior one is bordered behind with a similar small ridge (*A*—*e*), sulcated on its anterior side, and corresponding to the small furrow behind the posterior large ridge of the right valve (*B*—*e**). It will thus be evident, that the large central triangular projection of the left valve, and the two small ridges lateral to it, are three teeth, which respectively fit into the triangular space, and its two lateral furrows, of the right valve; and that, on the other hand, the two large ridges of the latter valve are also teeth, which fit into the two large furrows of the opposite one. It is stated by Lamarck and others, that there are two teeth in the right valve, and four in the left one, in *Trigonia;* but it is not correct to consider the large central triangular projection of the left valve as constituting two teeth; since it is clearly only one, which is dilated and hollowed out, or cleft, as it were, on its free side, so as to appear like two teeth joined at the base.[1] But, however different the parts of the hinge, properly so called, may be in the two valves, it is not the same with the rounded ridge which is prolonged beneath the anterior part of the hinge of the left valve, as it is perfectly conformable to that of the right valve; neither is it so with the impressions of the anterior adductor muscle, or of the posterior adductor and supplementary (pedal or visceral) muscles, which are perfectly symmetrical in both valves. The pallial impression extends from the anterior to the posterior adductor muscular impressions, without showing any trace of sinuosity.[2]

M. Agassiz includes in the present family the genera *Trigonia* and *Myophoria:* to these I propose adding the genus *Schizodus*. *Myophoria* and *Schizodus* appear to have been the earliest created forms of the family, as they are found in the Carboniferous, Permian, and Triassic deposits; whereas *Trigonia* apparently does not occur in any formations earlier than the Jurassic:[3] it has also been found in nearly all the subsequently-formed deposits, and is still an inhabitant of the present seas, though exceedingly limited both as regards localities and species.[4]

[1] The following is Lamarck's description of the dental system of *Trigonia:* "teeth cardinal, oblong, flattened on the sides, diverging, sulcated transversely: two in the right valve, and sulcated on both sides: four in the opposite valve, and sulcated only on one side." (Animaux sans Vertèbres, 2d Ed., t. vi, p. 512.)

[2] The paragraph with which this note is connected, is partly a verbatim copy, and partly an abridgment of Agassiz' description contained in his Memoir on the family *Trigoniidæ*.

[3] I have an impression, that M. Alcide d'Orbigny has described a South American species of *Trigonia*, which he considers to be carboniferous.

[4] When Agassiz wrote his Memoir, no species of *Trigonia* had been found in deposits newer than the secondary; but since then, tertiary species have been found in Australia; and, if my memory does not fail me, in South America, by M. A. d'Orbigny.

Genus *Schizodus*,[1] King. 1841

Tellinites, *Schlotheim.*
Axinus (obscurus), *James Sowerby.*
Isocardia (axiniformis), *Phillips.*
Cucullæa (Schlotheimi), *Geinitz.*
Donax (sulcata[2]), *J. de C. Sowerby.*
Sedgwickia[3] (*partim*), *M'Coy.*

Diagnosis.— Equivalved: inequilateral, the posterior side being the longest. *Anterior outline* rounded; *posterior,* tapering towards the extremity. *Right valve* with two smooth cardinal teeth: *left valve* with three.[4] The teeth of the left valve placed in front of those of the right valve: the central tooth of the former more or less bifid, according to species, on its free side, and embraced by both teeth of the opposite valve. *Pallial line* entire. Smooth, or ornamented with fine raised lines running parallel to the margins.

Type *Schizodus truncatus,* King.

My earliest enunciation of this genus was made in the 'Annals and Magazine of Natural History' for November 1844, where it is stated, that I proposed instituting "*Schizodus* for the Permian and Carboniferous Axinuses, to distinguish them from the London Clay *Axinus angulatus.*"[5] An incomplete diagnosis and a tolerably full description of it was afterwards inserted in the 'Geology of Russia,' vol. ii, pp. 308-9, 1845, by M. de Verneuil, to whom I had forwarded my MSS. I now propose adding a few more particulars to what has already been published on the subject.

The late Mr. James Sowerby, in No. 55 of the 'Mineral Conchology,' described a new fossil genus under the name of *Axinus,* in which he included two widely different

[1] Etym. σχιζω, I split; ὀδους, a tooth—the typical species having the central tooth of the left valve divided on its free side.

[2] This shell is one of the species described by Mr. J. de C. Sowerby in Mr. J. Prestwich's valuable memoir 'On the Geology of the Coal Field of Coalbrook Dale' (vide Trans. Geol. Soc. Lond., 2d series, vol. v). When in London, about 18 months since, Mr. Prestwich kindly allowed me to examine the originals of Mr. Sowerby's species; and I find from my memorandums made at the time, that *Donax? sulcata* (op. cit., pl. xxxix, fig. 1) is the *Isocardia axiniformis* of Phillips. *Venus? carbonaria,* J. de C. Sow. (op. cit., pl. xxxix, fig. 2), is another species of *Schizodus;* but as far as I have been able to ascertain, it does not appear to have received any other specific name: the same species, occasionally beautifully preserved, occurs in the carboniferous shales of Redesdale, Northumberland.

[3] *Sedgwickia,* which is typified with the *S. alternata,* M'Coy, is stated to be "entirely without hinge-teeth" (vide Synop. Carb. Fossils, p. 61). *Sedgwickia gigantea,* M'Coy, however, appears to be a species of *Schizodus;*—and the same may be said of *Leptodomus fragilis,* M'Coy, *Dolabra securiformis,* M'Coy, *Mactra ovata,* M'Coy, *Amphidesma subtruncata,* M'Coy, *Anatina deltoida,* M'Coy, *Axinus obliquus,* M'Coy, &c.

[4] In the original diagnosis published in the 'Geology of Russia,' vol. ii, p. 308, it is erroneously stated, through overlooking the small posterior tooth in the left valve (vide pl. xv, fig. 29 *A, e*), that each valve is furnished with two teeth.

[5] Annals and Magazine of Natural History, vol. xiv, p. 313.

shells—the *Axinus angulatus* of the London Clay, and the *A. obscurus* of the Magnesian Limestone. Both species agree remarkably well in their marginal outline—one side or extremity being rounded, and the opposite side somewhat pointed: in other words, the cardinal margin on one side of the umbones is convex, and, on the other side, sloping, or somewhat concave: in a more essential point, however, they differ so completely as to be referable, not only to different genera, but to different families. *Axinus angulatus* has the cartilage placed on the rounded side of the umbone; whereas in *A. obscurus* it is placed on the sloping side. It follows, from this difference, that the former shell is rounded behind, and acuminated in front; and that the latter is rounded in front, and acuminated behind: in short, in these respects (and some others which it is unnecessary to notice in the present place), *Axinus angulatus* possesses the characters of certain *Lucinidæ;* whereas *A. obscurus* agrees with *Trigonia.* Now, as Mr. J. Sowerby distinctly stated, that he considered the London Clay *Axinus angulatus* to be "the type of the genus,"[1] it follows that the so-called *Axinus obscurus* must be removed to some other generic group. It is herein placed in the present genus.

Schizodus in many respects appears to be closely related to *Myophoria,* Bronn. The dental system, for example, is apparently but slightly modified in each genus, judging from the figure which Goldfuss and Bronn have published of the teeth of the left valve of *Myophoria Goldfussi.* The thick posterior tooth of this species may be supposed to be the homologue of the bifid tooth of the corresponding valve of *Schizodus truncatus.* The same agreement may be asserted of the anterior tooth of both shells. As I am not acquainted with any published figure of the teeth of the right valve of *Myophoria,* it is impossible for me to proceed any further with the comparison.

As regards *Trigonia,* however, a more detailed comparison may be instituted. Notwithstanding the striking difference, apparent at first sight, there is a remarkable agreement between the dental system of the genus named and that of *Schizodus.* If we view the teeth of *Trigonia* as largely developed examples of their kind, and in the light in which they are described by Agassiz, not Lamarck and others, without attending

[1] Mr. Morris appears to have been the first to suggest that *Axinus angulatus* belonged to Turton's genus *Cryptodon* (vide Catalogue of British Fossils, p. 80); probably on account of its close resemblance to *Cryptodon flexuosus,* Montague, which is by some considered to be a species of *Lucina.* Considering the type of *Lucina* (viz. *Venus Jamaicensis,* Chem.), Montague's species evidently belongs to a distinct genus: if this be admitted, the name *Axinus* will have to be applied to it in preference to *Cryptodon;* as the former had a few months' priority, being published in the 'Mineral Conchology' No. 55, Dec. 1821; whereas the latter was not published until the early part of the following year. In noticing this circumstance elsewhere (vide Annals and Magazine of Nat. Hist., vol. xviii, p. 242), I find I have incorrectly stated, that No. 55 of the 'Mineral Conchology' was published in Dec. 1823. One great proof of the necessity of adopting the genus *Axinus,* as typified with *A. angulatus,* is in the fact that two or three species belonging to it have been made typical of three or four synonymous genera; for example, *Axinus, Cryptodon, Ptychina,* and (?) *Clausina.*

to their sulcated character, it will be seen, that in every essential point the agreement is complete: for example, referring to Plates XV, fig. 29 *A, B*, and XIX, fig. 8 *A, B*, there are three teeth in the left valve (*A—a, c, e*), and two in the right one (*B—b*, d**), of both genera. The central tooth of the left valve is bifid or hollowed out on its free side (*A—c*), and embraced by the diverging teeth of the opposite valve (*B—b*, d**), or, in other words, fitting into the triangular vacancy (*B—c**) between these teeth; further, each of the three teeth of the left valve fits into a depression in front of the teeth of the opposite valve (*B—a*, c*, e**). It will thus be evident, that the only essential differences between the teeth of *Schizodus* and *Trigonia* is in their being sulcated and unusually large in the one,—plain and of the ordinary size in the other.

With regard to the ridge behind the anterior muscular impression of *Trigonia*, it is obviously an exaggerated form of an ordinary character: it is absent in *Schizodus*, but present in *Myophoria*.

The various species of *Schizodus* are equivalve; some are very inequilateral (*S. axiniformis—Isocardia id.*, Phillips); while others are scarcely so, (*S. Rossicus*, De Vern., *S. carbonarius—Venus id.*, J. de C. Sow.) In general, they are more or less acuminated, or obliquely truncated posteriorly; the exceptions being rounded (*S. rotundatus—Axinus id.*, Brown, &c.): the umbones are more or less prominent; and, as in some species of *Cardium, Tellina*, &c., their curving is differently directed, being turned towards the anterior end in *S. axiniformis*, whilst in *S. obscurus* and others, they curve posteriorly. The teeth appear to be subject to certain modifications: the anterior tooth of the right valve is generally long, erect, and curved; but the posterior one appears to be variable: the latter in *S. truncatus*, King, (the species whose dental system I have studied with the most success,) is slightly oblique to the hinge-line below the cartilage-fulcrum; in *S. axiniformis* it appears to be directed more into the cavity of the shell; and in *S. Rossicus* and *S. carbonarius* it is so slightly developed, or so little separated from the hinge-plate, as to lose all distinctiveness.[1] The central tooth of the left valve of *S. truncatus* is bifid; but in *S. axiniformis* and *S. carbonarius* it is thick and undivided, approaching in form to the corresponding tooth of *Myophoria Goldfussi*.

In most of the species of *Schizodus* the valves are thin, and ornamented, particularly on the anterior side, with fine raised concentric lines, remarkably equidistant in certain species, for example, *S. axiniformis*.

The muscular impressions, owing probably to the thinness of the valves, are not generally displayed on casts; there is one species, however (*S. obscurus*), in which

[1] In a species of *Schizodus* found in the Glasgow carboniferous shales, the posterior tooth of the right valve is very much elongated, and runs nearly parallel to the hinge line.

(vide Pl. XV, fig. 23) the adductor muscular impressions (*a*, *b*), pedal or visceral ditto (*d*, *e*), and entire pallial line (*c*), are often instructively displayed.[1]

The cartilage of one of my specimens of *Schizodus axiniformis* is rather long, slightly prominent, and situated immediately behind the point of the umbones, that is, on the dorsal slope of the longest side of the shell.

Schizodus, *Myophoria*, and *Trigonia* are intimately related to each other. The dental system appears to be but slightly modified in each genus. In *Trigonia*, the teeth are massive, generally sulcated, and extending considerably into the cavity of the shell; the anterior ones are so far subject to the last condition, as to allow of the anterior adductor muscle being inserted before them. In *Myophoria*, the teeth are somewhat reduced in size, and plain—at least, generally so; the anterior teeth also project considerably into the cavity of the shell, or rather become joined to the ridge, which posteriorly bounds the anterior adductor muscular impression; hence the deep groove, in front of the umbones, in casts of this genus: in *Trigonia*, the ridge may be said to be an integral portion of each anterior tooth. In *Schizodus*, the teeth are still more reduced, and quite plain; and there is a complete absence of the muscle-bounding ridge. The differences just named are accompanied with others, which are external. *Trigonia* is generally ornamented with ribs, tubercles, and varices, frequently combined: *Myophoria* is usually characterised with a variable number of longitudinal ribs: and *Schizodus* is, in general, simply marked with fine raised concentric lines.

By means of its relation to *Myophoria* and *Schizodus*, the singular genus *Trigonia* stands in a less isolated position in our conchological systems than at first sight it would appear; it becomes, in fact, intimately connected with ordinary genera; inasmuch as its massive sulcated teeth are seen to graduate almost insensibly into those characteristic of the normally dentigerous Dimyarians.

All the known species of *Schizodus* belong to the Carboniferous and Permian formations.

[1] Dr. Geinitz has represented his *Schizodus Schlotheimi* with a deep sinus in the pallial impression: this is directly contrary to what I should have expected. However, so many errors have been made in connexion with this character, that I may be excused suggesting to Dr. Geinitz the propriety of a rigorous re-examination of the two specimens represented in the 'Versteinerungen' (pl. iii, figs. 31, 32). My specimens, unfortunately, do not display any muscular impressions, nor have I seen the pallial muscular sinus in *Schizodus truncatus*—the species typical of the genus. An entire pallial line is only displayed in one of my specimens of *Schizodus obscurus*—the one referred to in the text. It may be stated, however, that I have seen precisely the same character displayed on one of my casts of *Schizodus carbonarius*, which I have no hesitation in considering a congeneric species, both from its superficial ornamentation, and dental system.

SCHIZODUS OBSCURUS, *J. Sowerby*. Plate XV, figs. 23, 24.

AXINUS OBSCURUS, *J. Sow.* Min. Conch., vol. iv, p. 12, pl. 314, upper figure, Dec. 1, 1821.
(?) CARDIUM, N. S., *Phillips.* Phil. Mag., n. s., vol. iv, p. 401, 1828.
AXINUS OBSCURUS, *J. Sow.* Sedgwick, Trans. Geol. Soc. Lond., 2d series, vol. iii, p. 119, 1829.
— — „ De la Beche, Geol. Man., p. 384, 1831; Germ. Transl., p. 459, 1832; 3d Eng. ed., p. 573, 1833.
— — „ Phillips, Encyc. Met., vol. iv, p. 616, pl. iii, fig. 7, 1834.
— — „ Thomson, Outlines Min. Geol. &c., vol. ii, p. 310, 1836.
— — „ Phillips, Lardner's Cycl., Geology, vol. i, p. 190, fig. 4, 1837.
(?) — PARVUS, *Brown.* Trans. Manch. Geol. Soc., vol. i, p. 31, pl. vi, fig. 30, 1841.
— (sp. unnamed), *Brown.* Op. cit., vol. i, pl. vi, fig. 18.
(?) — UNDATUS „ Op. cit., vol. i, p. 31, pl. vi, fig. 31.
(?) — — „ Morris, Catalogue, p. 80, 1843.
(?) — PARVUS „ Loc. cit.
— OBSCURUS, *J. Sowerby.* Loc. cit.
— — „ Brown, Fossil Conchology, pl. lxxix, figs. 5, 6, 1843?
(?) — UNDATUS, *Brown.* Op. cit., pl. lxxix, fig. 9.
— (sp. unnamed), *Brown.* Op. cit., pl. lxxix, fig. 7.
— (SCHIZODUS) OBSCURUS, *J. Sow.* De Verneuil, Bull. Soc. Géol. de France, 2me série, vol. i, p. 31, 1844.
(?) — PARVUS, *Brown.* Loc. cit.
(?) — UNDATUS „ Loc. cit.
(?) — — „ Geol. Russ., vol. i, p. 224, 1845.
(?) — PARVUS „ Loc. cit.
— OBSCURUS, *J. Sow.* Loc. cit.
— — „ Philippi, Menke's Zeitschrift für Malakozoologie, p. 94, 1845.
SCHIZODUS — „ Tennant, Strat. List., p. 88, 1847.
— PARVUS „ Loc. cit.
— UNDATUS „ Loc. cit.

Diagnosis.—"Obovate, posteriorly cuneiform; anteriorly rounded; surface convex, with one obtuse keel; beaks large." (Sowerby.[1])

This well-known species is characterised with thick valves, as shown by the strongly-marked muscular impressions on casts (vide Pl. XV, fig. 23); a somewhat acuminated posterior end, caused by the ventral and dorsal margins sloping so much towards each other; a longitudinally-deep, rounded anterior end; and posteriorly twisted umbones.

The fossils which Captain Brown has placed in the genus *Axinus* appear to me to be referable to two species only, one of which I consider synonymous with *Schizodus*

[1] Mineral Conchology, vol. iv, p. 12.

obscurus. From an examination of the original specimen belonging to Mr. Binney, of the unnamed fossil represented in the 'Transactions of the Manchester Geological Society,' vol. i, pl. 6, fig. 18, I have little doubt of its belonging to this species. I cannot speak so confidently of the specimens represented by figs. 30 and 31, under the names of *Axinus parvus* and *Axinus undatus*, though I have a strong suspicion of their being the same. By tracing the lines of growth on Mr. Binney's specimen of the so-called *Axinus undatus*, I cannot perceive any flexure corresponding to the one in the ventral margin; on the contrary, the fossil appears to be broken where the flexure occurs.

Schizodus obscurus occurs very abundantly at Garforth Cliff Quarry near Leeds; Woodhall, Yorkshire; Stubbs Hill near Doncaster; and Nosterfield. Mr. Binney has collected it at Kirkby Woodhouse, Notts; Bolsover; near Elmsall, Yorkshire; Bedford, Atherton, Monton, Patricroft, and Newtown in Lancashire. It probably occurs at Ferrybridge; as Professor Phillips found a fossil there, which is supposed to be the present species. (Phil. Mag., New Series, vol. iv, p. 401, 1828.)

SCHIZODUS ROTUNDATUS, *Brown*. Plate XV, fig. 30.

	AXINUS ROTUNDATUS, *Brown*.	Trans. Manch. Geol. Soc., vol. i. p. 31, pl. vi, fig. 29, 1841.
(?)	— PUCILLUS (young), *Brown*.	Op. cit., vol. i, p. 31, pl. vi, fig. 32.
(?)	LUCINA MINIMA ,,	Op. cit., vol. i, p. 32, pl. vi, fig. 33.
	LAST THREE SYNONYMS ,,	Brown, Fossil Conchology, pl. lxxix, figs. 1, 2, 3, 10, 11, 12, 1843.
	Idem. ,,	Morris, Catalogue, p. 80, 1843.
	Idem. ,,	De Verneuil, Bull. Soc. Géol. de France, 2^{me} série, vol. i, pp. 31, 32, 1844.
	Idem. ,,	Geol. Russ., vol. i, p. 224, 1845.
	Idem. ,,	Tennant, Strat. List, p. 88, 1847.
(?)	SCHIZODUS SCHLOTHEIMI, *Geinitz*.	Versteinerungen, pl. iii, fig. 33, 1848.

Diagnosis.—"Shell nearly orbicular; umbones almost central, acute, and remote; surface smooth. Length upwards of three eighths of an inch; breadth nearly half an inch."[1] (Brown.)

This appears to me to be the only real species which Captain Brown has described; but it is much to be regretted that the original specimen is so badly preserved, that I am not able to speak with sufficient confidence on this point. By tracing the lines of growth, its posterior half is apparently shorter, and more rounded than in *Schizodus obscurus*, or any other congeneric species, with, perhaps, the exception of *Schizodus Rossicus*, which appears to resemble it very closely. Captain Brown is undoubtedly wrong in describing it as being smooth; as Mr. Binney's specimen is distinctly threaded parallel to the margin. It seems to have had rather thick valves.

Schizodus rotundatus was found by Mr. Binney in the Permian Marls at Newtown, near Manchester.

[1] Transactions of the Geological Society of Manchester, vol. 1, p. 31.

SCHIZODUS SCHLOTHEIMI, *Geinitz*. Plate XV, figs. 31, (?) 32.

(?) TELLINITES DUBIUS, *Schlotheim*. Akad. Münch., vol. vi, p. 31, pl. vi, figs. 4, 5, 1816.
— — „ Petrefactenkunde, p. 189, 1820.
— — „ Boué, Edin. Phil. Journ., vol. xii, p. 144, 1825.
CUCULLÆA SCHLOTHEIMI, *Geinitz*. Neues Jahrbuch, p. 638, pl. xi, fig. 6, 1841.
— — „ Gæa von Sachsen, p. 96, 1843.
AXINUS (SCHIZODUS) — „ De Verneuil, Bull. Soc. Géol. de France, 2me série, vol. i, p. 31, 1844.
— PARALLELUS, *King*. Loc. cit.
— — „ Geol. Russ., vol. i, p. 224, 1845.
— SCHLOTHEIMI, *Geinitz*. Loc. cit.
CORBULA — „ Grundriss, p. 414, pl. xix, fig. 12, 1846.
SCHIZODUS PARALLELUS, *King*. Tennant, Strat. List, p. 88, 1847.
— TRUNCATUS (*partim*), *King*. Catalogue, p. 11, 1848.
AXINUS OBSCURUS, *J. Sow*. Howse, Trans. T. N. F. C., vol. i, p. 246, 1848.
SCHIZODUS SCHLOTHEIMI, *Geinitz*. Versteinerungen, pp. 8, 9, pl. iii, figs. 23-26, &c. 1848.

Diagnosis.—Equivalved: inequilateral: transversely oval: rounded in front: elongated behind: obliquely truncated at the posterior extremity: obtusely angulated from the umbone to the posterior termination of ventral margin. *Valves* thin and strongly convex.[1]

The present specific name was originally applied by Dr. Geinitz to a fossil described and delineated in the 'Neues Jahrbuch' for 1841, p. 638, pl. xi, fig. 6, and which I am warranted in considering as the type of the species. By adopting this view, *Schizodus Schlotheimi* must be considered as decidedly distinct from *S. obscurus*; and as being more tumid at the umbones, and more inequilateral, than *S. truncatus*, the next species (to which it appears to be closely related),—the posterior side being considerably longer than it is in the last-named shell. Dr. Geinitz in the original description (loc. cit.), described it as being *very inequilateral*—"sehr ungleichseitig,"—an expression which I think ought to have been retained in the description published in the 'Versteinerungen.'

Schizodus Schlotheimi has prominent umbones: it is much and regularly rounded at

[1] The above diagnosis is a free abridgment of the following description of *Schizodus Schlotheimi* in the 'Versteinerungen,' pp. 8, 9: "Diese dünnschalige Muschel ist gleichschalig, ungleichseitig, quer-eiförmig, vorn gerundet und gleichmässig gewölbt, nach hinten verlängert und am Hinterrande schief abgeschnitten. Eine stumpfe Kante zieht sich von der Spitze des Wirbels nach der unteren hinteren gerundeten Ecke herab und schneidet den flachen, mit einer sanften Bucht sich herabziehenden Theil der Schale ab, welcher ausserdem von dem geraden Schlossrande und dem geraden Hinterrande begränzt wird, die beide mit einer stumpfen Ecke an einander stossen. Der übrige Theil der Schale ist stark gewölbt und wird in den älteren Exemplaren nach dem Wirbel hin bauchig. Dieser überragt mit einer starken Biegung den Schlossrand. Bei älteren Individuen liegt der Wirbel ungefähr in einem Drittel der Länge, bei jüngeren hat sich die Schale noch nicht so weit nach hinten ausgebreitet, und der Wirbel liegt etwas mehr nach der Mitte zu (*Sch. Rossicus*)."

the anterior margin; truncated obliquely at the posterior extremity; flatly convex at the ventral margin; and rather sloping behind the umbones.

Dr. Geinitz states that young specimens are not so elongated posteriorly, nor so inequilateral as old ones: this is precisely the case with specimens found in Durham; but I have never seen any so decidedly rounded marginally, or so nearly equilateral, as *Schizodus Rossicus*, which in the 'Versteinerungen' is, incorrectly I think, assumed to be the young of *S. Schlotheimi*. The fossil which Dr. Geinitz cites as an example (vide pl. iii, fig. 33) supporting his view, I am disposed to consider, belongs either to *Schizodus rotundatus*, Brown, or *S. Rossicus*.

The triassic (?) *Myophoria cardissoides*, Hartmann, represented in the 'Lethæa Geognostica,' pl. xiii, fig. 9, has some resemblance to *Schizodus Schlotheimi*, particularly the specimen represented in Plate XV, fig. 32, which I have, with some hesitation, identified with the Geinitzian species. The specimen cited, which is imperfect at the dorsal margin, and therefore represented with too great a slope at this part, has a portion of the shell remaining, which is thick and strongly laminated: the posterior oblique ridge is rather prominent; and immediately in front of and parallel to it, there is a shallow furrow, which has produced a slight sinus at the posterio-ventral margin. I have seen undoubted, but smaller, specimens of *S. Schlotheimi* somewhat sinuated in the same part.

Dr. Geinitz states that *Schizodus Schlotheimi* is a "characteristic shell in the upper Zechstein, in which it is everywhere associated with *Mytilus Hausmanni* (query *M. septifer*); also in the limestone of Paschkowitz near Mügeln, and of Frohburg in Saxony, of Cosma, Sommeritz, Lehndorf, Zehma near Altenburg, and Roschütz near Gera; in the Zechstein-Dolomite of Könitz, Glücksbrunn, Salzungen, Ahlstedt near Schleusingen, between Allendorf and Zizzendorf, and, according to Mielecki, in the neighbourhood of Osterode (Katzenstein), Scharzfeld and Sachswerfen (near Mühlberg in the white Dolomite) in the Hartz." In the county of Durham it is a characteristic fossil in the uppermost beds of the Permian series, and associated with *Mytilus septifer*: it has occurred to me in these beds at Roker, Suter-point Bay, Marsden, Cleadon Hills, Byers's Quarry, at the site of the new docks opposite Sunderland, and at the South end of Black Hall Rocks. I have never found it in the Shell-limestone of Humbleton Hill, or any other locality, associated with *Schizodus truncatus*, &c. The specimen represented in Pl. XV, fig. 32, was found by Mr. Binney at Newtown near Manchester: I have seen other specimens from the same locality. A fine specimen in the York Museum was collected at Stapleton Park.

SCHIZODUS TRUNCATUS, *King*. Plate XV, figs. 25, 26, 27, 28, 29.

(?) AXINUS OBSCURUS, *J. Sow.* Min. Conch., No. 55, p. 12, pl. 314, lowest figure, 1821.
(?) VENUS (?), *J. de C. Sow.* Trans. Geol. Soc. Lond., 2d series, vol. iii, p. 120, 1829.
(?) — (?) „ De la Beche, Geol. Man., p. 385, 1831; Germ. Transl., p. 459, 1832; 3d Eng. ed., p. 573, 1833.
AXINUS (SCHIZODUS) TRUNCATUS, *King*. De Verneuil, Bull. Soc. Géol. de France, 2me série, vol. i, p. 31, 1844.
— (—) — „ Geol. Russ., vol. i, p. 224, 1845.
SCHIZODUS — „ Tennant, Strat. List, p. 88, 1847.
— — „ King, Catalogue, p. 11, 1848.
AXINUS — „ Howse, Trans. T. N. F. C., vol. i, pp. 245-6, 1848.

Diagnosis.—Moderately inequilateral, the posterior side being the longest: a little wider than long, the width being an inch, and the length seven eighths: marked with dark spots on a light-coloured ground: finely threaded parallel to the margins, more decidedly on the anterior than on the posterior half: moderately tumid in the umbonal region: slightly tapering, and rather obliquely truncated, at the posterior side: regularly rounded anteriorly.

This remarkably pretty species differs from *Schizodus obscurus* in having thinner valves, the anterior half not so deep longitudinally, and the posterior half decidedly less acuminated: the last difference is caused by the slighter obliquity of the dorsal and posterior margins, and the more evenly and less rounded form of the ventral margin, as displayed in fig. 25, Pl. XV, which is a correct representation of the species. The small Russian Permian specimen represented in the 'Geology of Russia,' vol. ii, pl. xix, fig. 8, and considered by M. de Verneuil to be a variety of *Schizodus Rossicus* (p. 310), seems to be nearly allied to it; judging from some casts which I have examined belonging to the cabinet of Sir Roderick Impey Murchison.

Occasionally specimens occur showing marks of their original colours (vide Pl. XV, fig. 28), which consist of small oblong dark spots on a light ground, resembling what is generally displayed on the recent *Circe Castrensis*.[1]

Its dental system, already described, is pretty correctly represented in Plate XV, fig. 29.

Schizodus truncatus is rather a scarce fossil: specimens are found at Humbleton Quarry, Tunstall Hill, Silksworth, and Whitley Quarry in shell limestone.

[1] Marks of colour occur in other Permian fossils, as *Pleurotomaria antrina*, Schl., *Natica Leibnitziana*, &c. Professor Phillips has represented a beautifully-marked specimen of *Pleurotomaria carinata*, Sow. But the most striking instance of the kind that I have seen is on some of my specimens of a Carboniferous *Pecten*, which has wide red-coloured bands radiating from the umbones.

Family ASTARTIDÆ, King.

CRASSINIDÆ,[1] *J. E. Gray.*

I quite agree with Mr. Gray in making the genus *Astarte* typical of a distinct family group. The dental and muscular systems, thick epidermis, and some other characters, widely remove it from all those families in which Lamarck, Blainville, and other conchologists have placed it. *Astartidæ* agrees with *Trigoniidæ* only in being without a siphonal inflexion.

Genus *Astarte*, J. Sowerby.

CRASSINA, *Lamarck.*

Diagnosis.—"Suborbicular or transverse: subinequilateral: hinge with two diverging teeth: a depression before the beaks: impression of the cloak entire, exhibiting no siphon-cicatrix." (J. Sowerby.)[2]

As this genus, which contains several recent forms, was originally founded on a fossil species, and consequently not so fully described as could be wished, it has been considered necessary to add the description of it by Forbes and Hanley, the latest writers on the subject.

"Shell oblong, suborbicular or triangular, solid, equivalve, more or less inequilateral, sometimes nearly equilateral, closed; surface smooth, or transversely furrowed, and covered by a conspicuous epidermis. Muscular impressions ovate, strongly marked; pallial impression simple, rather distant from the margin. Hinge composed of two strong diverging primary teeth in one valve, and a primary tooth with a less supplementary one, which is sometimes obsolete, in the other. Ligament external, elongated, usually lodged in a lozenge. Lunule almost always distinct."[3]

It is suspected that the following species are the earliest created forms known.

ASTARTE VALLISNERIANA, *King.* Plate XVI, fig. 1.

ASTARTE	(?),	*J. de C. Sowerby.*	Sedgwick, Trans. Geol. Soc. Lond., 2d series, vol. iii, p. 119, 1829.
—	(?)	,,	De la Beche, Geol. Man., p. 385, 1831; Germ. Transl., p. 459, 1832; 3d Eng. ed., p. 573, 1833.
—	VALLISNERIANA, *King.*		Catalogue, p. 11, 1848.

[1] The epithet *Crassinidæ* having no generic typical name, in consequence of the general abandonment of Lamarck's *Crassina*, I have made free to substitute for it that of *Astartidæ*.

[2] Mineral Conchology, vol. ii, p. 85.

[3] A History of British Mollusca, vol. i, pp. 450-1.

Diagnosis.—Slightly inequilateral: marginal outline somewhat oval transversely:[1] umbones pointed: dorsal slope of each valve angulated: concentrically threaded.[2]

The general outline of this interesting species is somewhat oval in the transverse direction: its umbones are rather pointed; and the surface of both valves is crowded with sharp prominent striæ.

The specimen figured is a gutta-percha cast, of the natural size, taken from a natural impression. Another impression of the same species, and from which a number of similar casts might easily be taken, is in the London Geological Society's collection, presented by the Rev. Professor Sedgwick.

Whitley Quarry is the only locality known to me for *Astarte Vallisneriana*, where it is extremely scarce; though it would appear, that formerly specimens were more abundant. (Vide Sedgwick, loc. cit.)

ASTARTE TUNSTALLENSIS, *King*. Plate XVI, fig. 2.

Diagnosis.—Nearly circular in its marginal outline: slightly inequilateral, the posterior half being the widest, also the deepest: rather tumid at the umbones: concentrically threaded: nearly a quarter of an inch in width.

This species might be taken for the young of the former; but it differs in having the posterior half longitudinally deeper, compared with the anterior half; the dorsal margin less sloped; and the umbones more tumid. It is similarly ornamented with concentric striæ.

I have only found a single specimen, the one figured, of this species in the Shell-limestone of Tunstall Hill.

Family PHOLADOMYIDÆ, King, 1844.

M. de Blainville's family *Pyloridæ*, and all the synonymous groups proposed by other naturalists, are so heterogeneous, that I was induced some time since[3] to propose the present one for *Pholadomya* (the type), *Panopæa*, *Lysianassa* (Münster), *Cercomya* (Agassiz), and the following genus.

The genera named are characterised with transversely oblong valves, an external cartilage, a sinuated pallial line, and a slightly developed or extremely simple dental system: judging from *Pholadomya* and *Panopæa*, the only recent genera known, the cloak of the animal is entirely closed, with the exception of an anterior opening for the passage of the foot, and an ingress and an egress orifice at the termination of a long, posterior, siphonal sheath.

[1] In my Catalogue this species is incorrectly stated to have its "ventral outline semicircular."

[2] King, Catalogue, p. 11.

[3] Vide Annals and Magazine of Natural History, vol. xiv, p. 315.

Genus *Allorisma*,[1] King, 1844.

Myacites,[2] *Schlotheim.*
Hiatella (sulcata), *Fleming.*
Sanguinolaria (gibbosa), *J. de C. Sowerby.*
Unio (urii[3]), *J. de C. Sowerby.*
(?) Lutraria (prisca), *Goldfuss.*
Pholadomya (elongata), *Morton.*
(?) Sanguinolites (*partim*), *M'Coy.*[4]
Orthonota (*partim*), *J. W. Salter.*[5]

Diagnosis.—Equivalved: inequilateral, the posterior side being the longest: in general slightly gaping. *Valves* granulated on the surface; more or less undulated or ribbed parallel to the free margins; and articulating with each other by means (only) of an external cartilage. *Anterior adductor muscular impressions*, in general, near the anterio-ventral margin. *Sinus* deep in some species, and shallow in others.

Type *Hiatella sulcata*, Fleming.[6]

[1] Etym. ἀλλοῖος, variable; ἔρεισμα, support. The name was originally proposed under the persuasion that the cartilage fulcra of the genus varied in position according to species (vide Annals, loc. cit.; and *ante*, p. 163): this is now known to be an error: the name is, however, still retained, notwithstanding its being a misnomer.

[2] Schlotheim's name *Myacites* implies that the shells so called are fossil Myas; as this is not the case, the name cannot stand.

[3] Having been favoured with an examination of the original of this species in Mr. J. Prestwich's valuable collection of Coalbrook Dale fossils, I feel it necessary to state, that it is not the *Unio Urii* of Dr. Fleming; but, on the contrary, it appears to be his *Hiatella sulcata*. *Nucula occipiens* of J. de C. Sowerby (Trans. Geol. Soc. Lond., 2d series, vol. v, pl. xxxix, fig. 4), in the same collection, is not of the genus so named; but a small or young *Allorisma* nearly related to *A. constricta*, King. Perhaps the so-called *Unio Ansticei* is another congeneric species.

[4] The only species placed in *Sanguinolites* (=*Edmondia*) by Professor M'Coy belonging to *Allorisma*, is apparently, Phillips's *Sanguinolaria tumida*. My remarks on *Edmondia* will have shown that there is no relation between *Allorisma* and *Sanguinolites*.

[5] Mr. Salter makes *Allorisma* synonymous with (Conrad's?) *Orthonota*, his own *Meristomya*, and M. de Verneuil's *Grammysia* (vide Appendix to Professor Phillips's Memoir on the Malvern Hills, in Mem. Geol. Survey, vol. ii, part i, pp. 359-60). Judging from the type of Conrad's genus *Orthonota*, namely *O. undulata*,—which has a long straight hinge line, an oblique fold running with a posterior deflection from the umbone to the ventral margin, and the dorsal and ventral outlines parallel to each other,—the synonymy is obviously a strained one. Is the diagnosis of *Orthonota* given in the Memoir cited, an emendation (which it is stated to be) by Conrad or Salter? If by the former, this genus cannot be the same as *Allorisma*; as it is stated to have the "pallial impression entire:" if by the latter, I may be allowed to ask—has this character been seen in the typical species?

[6] I embrace the present opportunity of naming this species as the type of *Allorisma* in preference to *A. regularis* (Geol. Russ., vol. ii, pl. xix, fig. 9); as I am more acquainted with it than the latter. The fossil represented by De Verneuil in the 'Geology of Russia,' vol. ii, pl. xxi, fig. 11, and considered a specimen of *Allorisma regularis*, is not of this genus: it is an *Edmondia*, as proved by the linear groove along the hinge, which has resulted from one of the cartilage fulcra.

The reasons for restricting *Allorisma* to certain kinds of shells have already been stated under the head of *Edmondia*.

Typified with the foregoing species, the present genus embraces a number of palæozoic forms, which are edentulous, oblong transversely, more or less wrinkled in the same direction; possess small umbones,[1] and an external cartilage; have a granulated exterior, and the anterior adductor muscular impressions proximo-ventrally situated.

It closely agrees with certain secondary Panopæas in form, and in being granulated externally. There is also a further agreement; inasmuch as in some of these shells, for example, the so-called *Lutraria gibbosa*, Sow., and *L. decurtata*, Goldfuss, the teeth are little more than rudimentary, or mere flexuous expansions of the cardinal margins,—not strong conical projections, as in the recent *Panopæa Aldrovandi*, and *P. Norvegica*. It would thus appear, that the forms noticed constitute a transitional link between *Allorisma* and the normal species of *Panopæa:* whether these transitional forms ought to be considered as constituting a distinct generic group, which I have an impression has been named *Platymya* by Agassiz, is a point on which I am not at present prepared to enter.

Pholadomya is another genus with which *Allorisma* is intimately related; it differs, however, in having a number of ribs passing posterio-obliquely from the umbone to the ventral margin of the valves; in being, in general, widely gaping at the ends; and, perhaps, in the nature of its shell-tissue.[2] As regards hinge-characters, both genera are in accordance with each other, that is, they are divested of teeth, and have an external cartilage.

The two co-ordinate and related groups *Lysianassa*, Münster, and *Cercomya*, Agassiz, require only a passing allusion; as the former with its V-shaped ribs, and the latter with its attenuated posterior extremity, are clearly distinct genera.

Allorisma, as now restricted, was, I believe, the first palæozoic genus made known, as possessing a sinus in the pallial impression. Shortly before I published my first paper on the genus, I had seen this character faintly displayed on a specimen of the so-called *Hiatella sulcata*, Fleming, in Mr. Tate's collection; and since then I have repeatedly collected specimens of the same shell in Redesdale, with it displayed in the most satisfactory manner. The specimen represented in Pl. XX, fig. 5, fully illustrates both the pallial and adductor muscular impressions of the genus. Looking at another species elsewhere represented (Pl. XVI, fig. 3), it is evident, that the pallial sinus, in its varying depth, affords good grounds for specific differences; as in *Allorisma constricta*,

[1] *Allorisma Munsteri* (*Pholadomya, id.*), D'Archiac and De Verneuil, possesses rather large umbones.

[2] *Pholadomya*, judging from the nacreous character of its species, appears to have its shell-tissue of the same nature as that of *Pandora* and *Lyonsia;* whereas *Allorisma*, from its granular surface, has apparently a tissue agreeing with that of *Thracia*. The distinctive characters of the histology of *Pandora* and *Thracia* have been published by Dr. Carpenter in his 2d report 'On the Microscopic Structure of Shells,' in the British Association Report for 1847.

the pallial line is even less inflected than it is in *A. elegans*, the species just referred to. The low or proximo-ventral position of the anterior adductor muscular impressions, which is striking compared with the position of the same impressions in *Mya*, *Lutraria*, *Panopæa*, and some other genera, appears to be indicative of *Allorisma* having been more a surface-creeping, than a decidedly burrowing genus. That the position of the anterior adductor muscle is influenced by the terebrating habits of the mollusk, is strongly evidenced by the fact, that in the decidedly burrowing genera, *Pholas*, *Teredo*, and *Xylophaga*, this muscle is situated considerably above its usual situation,—so high in some, that the surfaces to which it is attached, or the anterio-cardinal margins of the valves, project externally in front of the umbones, and are even in some species, such as *Pholas dactylus* and *P. candida*, reflected considerably over them. *Thracia pubescens* has the anterior adductor muscular impressions as low as in *Allorisma*. Perhaps the foregoing observations may induce those, possessing the opportunity, to endeavour to ascertain if the habit of this species is confirmatory of the view herein taken of that of *Allorisma*.[1]

The present genus, supposing the so-called *Pholadomya Munsteri*, D'Archiac and De Verneuil, to be a species, is not known to occur in earlier than the Devonian rocks: it is rather common in the Carboniferous; meagrely represented, at least as far as is known, in the Permian; and anything but abundant, taking *Myacites* to be the same, in the Triassic deposits. I have not yet been able to satisfy myself of its existence in any rocks of a later age.

ALLORISMA ELEGANS, *King*. Plate XVI, figs. 3, 4, 5.

ALLORISMA ELEGANS, *King*. De Verneuil, Bull. Soc. Géol. de France, 2me série, t. i, p. 30, 1844.
— — ,, Ann. and Mag. Nat. Hist., vol. xiv, p. 316, 1844.
— — ,, Geol. Russ., vol. i, p. 223, 1845.
(?) AMPHIDESMA LUNULATA, *Keyserling*. Petschora-land, p. 258, pl. xi, fig. 16, 1846.
(?) CYPRICARDIA BICARINATA ,, Op. cit., p. 257, pl. x, fig. 17.
ALLORISMA ELEGANS, *King*. Tennant, Strat. List, p. 88, 1847.
— — ,, Catalogue, p. 12, 1848.
SANGUINOLITES ELEGANS, *King*. Howse, Trans. T. N. F. C., vol. i, p. 243, 1848.
PANOPÆA LUNULATA, *Keyserling*. Geinitz, Versteinerungen, p. 8, pl. iii, figs. 21-2, 1848.

Diagnosis.—"*Form* very inequilateral: *both ends* closed; anterior one the shortest, and oblique superiorly; posterior one rather square: *umbones* somewhat gibbous: *dorsal slopes* with a faint angle running from the umbone to the posterior end of the shell: *surface* slightly wrinkled transversely, and crowded with minute pimples: *pallial sinus* somewhat shallow." (King.)[2]

[1] I have seen several hundred specimens of *Allorisma sulcata* in situ, that is, in a bed of shale in Redesdale; but I have never seen any in an upright or inclined position, so as to indicate that they were a burrowing species.

[2] Catalogue, p. 12.

This is a regularly formed species, apparently identical with both the *Amphidesma lunulata* and *Cypricardia bicarinata* of Count Keyserling: the former species has the same pre-umbonal lanceolate depression, approximating umbones, and obliquely truncated anterior side; and the latter, the same granulated exterior, dorsal slope defined by a faint angle running from the umbones to the posterio-ventral margin, and squared posterior extremity,—as those characteristic of *Allorisma elegans*.

Besides the lanceolate depression in front of the umbones, there is another behind them, rather deep, and extending the full length of the hinge-margin (Pl. XVI, fig. 4): neither exactly agree with what are usually termed *lunette* and *corselet;* though it is evident, they are but modified forms of these characters.

The granulated surface of this species has some resemblance to that of *Allorisma gibbosa* (*Sanguinolaria id.*, J. de C. Sow., 'Min. Conch.' pl. 548, fig. 3), which, it may be observed, although an allied species, has the extremities more acuminated. The granules, it will be seen, by a reference to Pl. XVI, fig. 5, display a tendency to fall into an obliquely linear arrangement.

The characters of the muscular impressions are represented in fig. 3, Pl. XVI. The pallial sinus (*c*) is very oblique to the ventral margin, offering, in this respect, a striking contrast to that of *Allorisma sulcata* (Pl. XX, fig. 5, *c*). The anterior adductor muscular impression (*a*), which is represented a little too high, has its lower border nearly horizontal with the posterior angle of the pallial line.

Allorisma elegans occurs in the Shell-limestone at Humbleton Hill, and in the lowest beds at Whitley Quarry, where it is rare. Dr. Geinitz records its occurrence in the under Zechstein of Thieschütz near Gera, and Corbusen near Ronneburg. The so-called *Amphidesma lunulata* was found in Permian Marl on the Uchta, a tributary of the Wymm, by Count Keyserling, who also discovered, in the same place, the so-called *Cypricardia bicarinata*, which is further recorded as being found in the Permian Limestone on the Wel near Kischerma.

Family Psammobiidæ (*partim*), Fleming, 1828.

Dr. Fleming made the following genus typical of the present family,—a receptacle in which he also placed *Astarte*. Having made the latter typical of a distinct family, it is herein excluded from *Psammobiidæ*, which, perhaps, embraces most of the genera subsequently grouped together by Mr. J. E. Gray and others under the name of *Tellinidæ*.

Genus *Psammobia*, Lamarck.

Diagnosis.—" Shell transversely oblong, equivalve, subinequilateral, slightly gaping at the extremities; surface smooth, or transversely, and more or less radiatingly

striated, invested with a thin epidermis. Muscular impressions round; pallial sinus strongly marked. Hinge composed of cardinal teeth, two or a single bifid tooth in one valve, and one in the other; supplementary laminæ small, and often obsolete. Ligament prominent, external." (Forbes and Hanley.[1])

PSAMMOBIA (?) SUBPAPYRACEA, *King*. Plate XVI, fig. 6.

PSAMMOBIA? SUBPAPYRACEA, *King*. Catalogue, p. 12, 1848.
TELLINA DUNELMENSIS, *Howse*. Trans. T. N. F. C., vol. i, p. 243, 1848.

Diagnosis.—"A thin, smooth, elliptical species. *Length* one third of its width: *umbones* slightly prominent, one third of the width of the valves from the anterior end: *terminations* rounded." (King.[2])

The fossil under consideration, which rarely exceeds an inch in width, is provisionally placed in the present genus; as nothing certain is yet known respecting its dental and muscular characters. Judging from its outline,—some slight indications of cardinal teeth,—and, the absence of the posterior flexure, which certain *Psammobiidæ* possess, notably *Tellina*, the present genus seems to be its most appropriate receptacle.

Psammobia (?) *subpapyracea* occurs very rarely in the Shell-limestone of Humbleton Hill.

Class GASTEROPODA, Cuvier.

MONOTHYRA, *Aristotle*.
TRACHELIPODA, &c., *Lamarck*.
PARACÉPHALORES, *Blainville*.
LES APTÉRYGIENS, &c., *Latreille*.
UNILOCULAIRES (*partim*), *De Montfort*.
UNIVALVES.

Diagnosis.—"Body free: with an abdominal foot suitable for creeping, and in some cases for swimming. *Head* in general distinct, usually bearing one or more pairs of tentacles. *Eyes* situated nearly always on or near the tentacles.[3] *Respiratory organs* branchial or pulmonary, and very variable in their position. *Shell* either external or

[1] British Mollusca, vol. i, p. 270. Feeling averse to overlooking the original diagnosis of a genus or species, I transcribe the following description of *Psammobia* by its founder: "Testa transversa, elliptica aut ovato-oblonga, planiuscula, utroque latere paulisper hians; natibus prominulis. Cardo dentibus duobus in valvâ sinistrâ; dente unico inserto in oppositâ." (Animaux sans Vertèbres, 2d ed., t. vi, pp. 170-1.)

[2] Catalogue, p. 12.

[3] *Chitonidæ* possesses no eyes.

internal;[1] single or divided, and conical or spiral in the first case; and more or less rudimentary in the second."[2]

In accordance with the prevailing view, the present division is herein considered to be co-ordinate with the last, and placed in the same great section of the Molluscous sub-kingdom. Viewing it in all its modifications, there cannot be said to be more than an approximate connexion between the two divisions; in short, there appears to be an impassable *hiatus* between the Gasteropods and the Lamellibranchs.

The class *Gasteropoda* is divisible into the following ten minor sections or *Orders*: 1, *Phlebenterata* (Limapontias); 2, *Gymnobranchiata* (Sea Slugs); 3, *Nucleobranchiata* (Carinarias); 4, *Polyplaxiphoria* (Chitons); 5, *Cyclobranchiata* (Limpets); 6, *Hypobranchiata* (Phyllidias); 7, *Pomotobranchiata* (Sea Hares); 8, *Cœlopnoa* (Land Shells, &c.); 9, *Aspidobranchiata* (Ear Shells); 10, *Ctenobranchiata* (Whelks); and 11, *Cirrhobranchiata* (Tooth Shells).[3] The probability is, that most of these orders have existed during all the organic periods of our planet; but, owing to various circumstances, especially to some being without any enduring remains, their chronogeny will long remain one of the most difficult problems in Malacology. As yet only three orders, the fourth, tenth, and eleventh of the above list, are known to have existed during the Permian epoch.

Order Polyplaxiphoria, De Blainville.

This group is usually associated with *Patellidæ* in the order *Cyclobranchiata;* but it differs from the family named in too many important points to be so closely united with it in a systematic arrangement: 1st, the shell is divided; 2d, the gills are in the form of triangular leaflets; 3d, the margin of the mantle is thick, and generally extended beyond the shell; 4th, the muscular system is much and complexly divided; 5th, the generative organs have two openings; 6th, the head is projecting; 7th, there are no tentacles; and 8th, there are no eyes.[4] De Blainville elevated *Polyplaxiphoria* to the rank of a class, and associated it with *Cirrhopodia* (= *Némotopodes*, Blainville) to form his sous-type *Malentozoaires*. This association is obviously erroneous; and the position of *Polyplaxiphoria* appears to be too elevated. But there seem not to exist any serious objections to our considering the group as of co-ordinate value with the other orders included in the present class.

[1] Three orders of Gasteropods are without shells, except in the earliest stage.

[2] Slightly altered from Sander Rang. (Vide Manuel des Mollusques, p. 119.)

[3] The hybrid names of Cuvier are herein discarded for the more classically constructed ones of Schweigger.

[4] Vide Animaux sans Vertèbres, 2d ed., vol. vii, pp. 487-9.

Family CHITONIDÆ (*Les Oscabrions*), Cuvier.

The genera of this group are furnished with a row of shelly plates placed on the back of the mollusk, and extending from the head to the tail. The Rev. Lansdown Guilding[1] and Mr. J. E. Gray, but more particularly the latter,[2] have instituted for the recent species a number of new genera; and considering the modifications presented by extinct forms, particularly protozoic species, which are, unexpectedly, rather abundant, it is extremely probable, that many more will be hereafter added. Mr. J. W. Salter has already made a beginning among the latter, by proposing the genus *Helminthochiton* for a singular fossil discovered by Dr. Griffith in the Silurian beds of county Galway.[3] Probably the fossil immediately to be described belongs to one of the many genera proposed of late by Mr. J. E. Gray; but, in the absence of precise knowledge on the subject, I am compelled to collocate it as follows.

Genus *Chiton*, Linnæus, 1758.

Diagnosis.—"Shell divided, constituting a series of imbricated dorsal plates, eight in number; mouth with a semicircular curved membrane above, destitute of tentacula." (Fleming.[4])

CHITON LOFTUSIANUS,[5] *King*. Plate XVI, figs. 9, 10, 11, 12, 13, 14.

CHITON, *King*. Ann. and Mag. Nat. Hist., vol. xiv, Nov. 1844.
— ,, London Geological Journal, vol. i, p. 10, figs. 1-4, 1846.
— LOFTUSIANUS, *King*. Catalogue, p. 12, 1848.
— ,, Howse, Trans. T. N. F. C., vol. i, p. 242, 1848.

Diagnosis.—*Plates* somewhat thick; marked with incremental lines on the lateral areas, which, together with the dorsal areas, are also finely granulated exteriorly. *Dorsal or intermediate plates*—some (? 2d) long in the middle, the posterior margin of which is pointed, and the anterior straight—others (? 4th, 5th, and 6th) short, projecting behind, and deeply sinuated in front. *Cephalic plate* with the apex elevated; slightly sinuated in front. *Caudal plate* capuliform; apex nearest the anterior margin, which is slightly sinuated,—also the posterior margin. *Apophyses* rather projecting; with a

[1] Zoological Journal, 1829.

[2] Ann. and Mag. of Nat. Hist., vol. xx, p. 131; and Op. cit., 2d series, vol. i, p. 228.

[3] Vide 'A Synopsis of the Silurian Fossils of Ireland,' pp. 71-2; and 'Quarterly Journal of the Geological Society,' vol. iii, part i, pp. 48-52.

[4] British Animals, p. 288.

[5] This species is named "after Mr. W. K. Loftus, to whom I was first indebted for the idea, that it belonged to the genus *Chiton*." (King, Catalogue, p. 12.)

convex margin; occupying the lower half of the margin of each lateral division of the dorsal areas. *Line of demarcation between the dorsal and the lateral area* rather slightly defined. *Dorsal area* bisulcated medio-longitudinally; the sulcations slightly divaricating. *Lateral areas* narrow.

Chiton Loftusianus (my discovery of which has elsewhere been noticed[1]) is a pretty species, and appears to have been about two inches in length. The above description will probably enable those conversant with the family to decide as to which genus it strictly belongs;[2] and for this purpose I have taken some pains in endeavouring to ascertain the character of the apophyses or processes of insertion of the plates, one of which, belonging to an intermediate plate, I have fortunately been able to free from its investing matrix. The representations of the intermediate plates in Pl. XVI will afford an idea as to their varying form: fig. 11 is suspected to be the second, considering the cephalic plate as the first one: fig. 13 may be the third, or one of those behind it: fig. 12 is perhaps the seventh or penultimate plate. Fig. 9 represents the cephalic plate, which has the apex broken off. Fig. 10 is a representation of the caudal plate, which, however, does not give so clear an idea of its form as could be desired; owing to the margin of the anterior side (*left* in the plate) being too much elevated: the consequence is, that this margin appears to be more deeply sinuated than it really is, and the anterior side is apparently larger than the posterior, which is quite the reverse; and, on the other hand, the sinuated character of the opposite or posterior margin is not represented. The posterior portion of the caudal plate is slightly concave medio-longitudinally.

This is an extremely rare species, having only occurred to me in the Shell-limestone of Humbleton Hill. I found two plates of what appear to belong to a *Chiton*, in a fragment of Permian Limestone from Kirkby Woodhouse, Notts, sent to me by Mr. E. W. Binney of Manchester.

Order Ctenobranchiata, Schweigger.

Pectinibranchiata, *Cuvier*.

Diagnosis.—"Branchiæ in the form of sessile, pectinated ridges, contained in a cavity." (Fleming.[3])

Dr. Fleming has divided this group into two sub-orders, namely, *Holostomata* and *Solenostomata*, respectively depending on their shell having the lip of the aperture

[1] Vide Annals and Magazine of Natural History for November, 1844.

[2] Mr. J. W. Salter seems to think, that it is a species of *Helminthochiton* (vide Quarterly Journal of the Geological Society, vol. iii, part i, p. 51); but I cannot agree to this if *Helminthochiton Griffithi* is to be considered as the type of this genus.

[3] British Animals, p. 225.

entire, as in the Whelk, or "canaliculated for the reception of the siphon of the branchial cavity,"[1] as in the Spindle-shell. No examples of the last division have yet been found in deposits of the Permian epoch; and it is doubtful whether any were created until a later period.

Holostomata, *Fleming*.

Asiphonobranches,[2] *De Blainville*.

Diagnosis.—"Aperture of the shell entire, together with the anterior margin of the cloak at the entrance of the branchial cavity." (Fleming.[3])

Family Turbinidæ (*Les Turbinacées, partim*), Lamarck.

This group is herein restricted to genera with a perlaceous shell-tissue, and a calcareous operculum.

Genus *Turbo*, Lamarck, not Linnæus.

The following five species are provisionally placed in the present group; for until we know the character of their operculum, and whether they were perlaceous or non-perlaceous, it is impossible to form any conclusion as to their proper generic position.

Turbo helicinus, *Schlotheim*. Plate XVI, figs. 21, 22.

Trochilites helicinus, *Schl.* Petrefactenkunde, p. 161, 1820.
Trochilinus — ,, Boué, Edin. Phil. Journ., vol. xii, p. 144, 1825.
Trochilites — ,, Quenstedt, Wiegmann's Archiv, pl. ii, p. 88, 1835.
Turbo minutus, *Brown*. Trans. Manch. Geol. Soc., vol. i, p. 63, pl. vi, figs. 4, 5, 1841.
— helicinus, *Schl.* Leonhard und Bronn's Jahrbuch, p. 638, 1841.
— minutus, *Brown*. Fossil Conchology, p. 74, pl. xxxvii*, figs. 17, 18.
— Meyeri, *Münster*. Goldfuss's Petrefacta, 3d Part, p. 92, pl. cxcii, fig. 14 *a*, *b*.
— minutus, *Brown*. Morris, Catalogue, p. 165, 1843.
— Meyeri, *Münster*. Geinitz, Gæa von Sachsen, p. 95, 1843.
Trochus helicina, *Schl.* De Verneuil, Bull. Soc. Géol. de France, 2me série, vol. i, p. 35, 1844.
Turbo minutus, *Brown*. Loc. cit.
— — ,, Geol. Russ., vol. i, p. 225, 1845.
Trochus helicina, *Schl.* Loc. cit.

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[1] Op. cit. p. 296.

[2] As terms implying negative characters are decidedly objectionable, Fleming's name has been preferred.

[3] British Animals, p. 296.

Turbo minutus, *Brown*. Tennant, Strat. List, p. 89, 1847.
— Tunstallensis, *King*. Catalogue, p. 13, 1848.
Littorina Mancuniensis (*partim*), *Brown*. Howse, Trans. T. N. F. C., vol. i, pp. 239, 240, 1848.
Trochus helicinus, *Schl.* Geinitz, Versteinerungen, p. 7, pl. iii, fig. 14 *a*, *b*, 1848.

Diagnosis.—Short: conical: with four tumid whorls, which are marked with five or more spiral line-like ridges, separated from each other at nearly equal distances.[1]

The distinctive characters of this species, which rarely exceeds three eighths in height, and the same in width, are its tumid whorls, rather prominent spiral ridges, and short spire. Having seen the original of Captain Brown's *Turbo minutus*, I feel quite satisfied that it is the present species.

Turbo helicinus occurs at Tunstall Hill, in Shell-limestone, and at Newtown (where it occurs under a stunted form) near Manchester, in the Permian Marls (Binney). Professor Phillips's collection contains a specimen collected at Aldfield, in Yorkshire. A single specimen occurred to me in the Dogger-bank fragment of Magnesian Limestone. Geinitz states that it occurs in the Zechstein-dolomite of Glücksbrunn; and according to Credner, it is found on the Wartberg near Seebach, in Thuringia.

Turbo Mancuniensis, *Brown*. Plate XVI, figs. 19, 20.

(?) Trochilites antrinus, *Schl.* Akad. Münch., pl. vii, fig. 6 *a*, *b*, not *c*, 1816.
(?) Turbo (?) Sedgwick, Trans. Geol. Soc. Lond., 2d series, vol. iii, p. 118, 1829.
(?) — (?) De la Beche, Geol. Man., p. 384, 1831; Germ. Ed., p. 459, 1832; 3d Eng. Ed., p. 573, 1833.
(?) — (?) Phillips, Encyc. Met., vol. iv, p. 618, 1834.
— Mancuniensis, *Brown*. Trans. Manch. Geol. Soc., vol. i, p. 63, pl. vi, figs. 1, 2, 3, 1841.
— — ,, Brown, Fossil Conchology, p. 74, pl. xxxvii*, figs. 15, 16.
— — ,, Morris, Catalogue, p. 165, 1843.
— — ,, De Verneuil, Bull. Soc. Géol. de France, 2me série, t. i, p. 35, 1844.
— — ,, Geol. Russ., vol. i, p. 225, 1845.
— — ,, Tennant, Strat. List, p. 89, 1847.
— — ,, King, Catalogue, p. 13, 1848.
Littorina — ,, Howse, Trans., T. N. F. C., vol. i, p. 239, 1848.

Diagnosis.—"Shell ovate; body large; spire short, consisting of three ventricose

[1] 'Versteinerungen,' p. 7. The following is the original description published by Dr. Geinitz; "Kurzkegel förmig mit vier gewölbten Umgängen, an welchen sich oben eine erhabene Linie bemerkbar macht, unter der die letzte Windung noch gegen fünf Linien zeigt, die ziemlich gleich weit von einander entfernt liegen. Auch erscheinen zwei feinere Linien noch in der Nähe der Naht."

volutions separated by a channelled suture; body provided with many prominent, spiral ribs; three on the body above, with five or six concentric ones beneath, and two on each of the volutions of the spire; these are crossed by numerous longitudinal wrinkles; aperture large, orbicular; outer lip expanded, smooth; pillar lip with an oblong umbilicus behind it. Length upwards of a quarter of an inch; body nearly the same in diameter." (Brown.[1])

A small species, possessing some resemblance to the last, but differing from it in having the spire more acuminated, the whorls less tumid, and the spiral ridges generally stronger and more numerous; the ridges range from six to nine in number. It appears to have been ornamented with longitudinal coloured bands parallel to the incremental laminæ, which are rather prominent.

Young specimens are somewhat umbilicated. My largest specimen is five sixteenths of an inch in height, and four sixteenths in width.

Turbo Mancuniensis occurs in the Shell-limestone at Tunstall Hill; in the Breccia at the north end of Black Hall rocks; and in the Permian Marls at Newtown near Manchester, though considerably smaller in this locality than in the two former. Probably it occurs in the pisolitic Yellow Limestone between Marr and Hickleton.[2]

Turbo Permianus, *King*. Plate XVI, fig. 16.

Turbo Permianus, *King*. Catalogue, p. 13, 1848.

Diagnosis.—"Spires four, smooth, length under a quarter of an inch."[3] *Aperture* orbicular: *inner lip* slightly reflected.

A species, generally agreeing with the above description, but occasionally exhibiting several faint spiral striæ, has occurred to me in various localities. My largest specimen is four sixteenths of an inch in height, and three sixteenths in width.

Professor Phillips cites Hawthorn Hive as a locality for this small species: it occurred to me at Silksworth, Byers's Quarry, Humbleton, Tunstall Hill, and Hylton North Farm. Fossils probably identical with it are rarely found in the Blue Limestone of Polterton and Bolsover; and in the lower beds of Yellow Limestone near Conisborough. (Sedgwick.)

Turbo Thomsonianus,[4] *King*. Plate XVI, figs. 23, 24.

Turbo Thomsonianus, *King*. Catalogue, p. 13, 1848.
Littorina Tunstallensis, *Howse*. Trans. T. N. F. C., vol. i, p. 240, 1848.

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[1] Transactions of the Manchester Geological Society, vol. i, p. 29.

[2] Vide Sedgwick, Trans. Geol. Soc. Lond., 2d series, vol. iii, p. 118.

[3] Phillips, Trans. Geol. Soc. London, 2d series, vol. iii, p. 118.

[4] Named after the late Dr. Thomas Thomson, F.R.S., author of 'A Geognostical Sketch of the Counties of Northumberland, Durham, and part of Cumberland,' in the Annals of Philosophy, vol. iv, 1814.

Diagnosis.—Three sixteenths of an inch in height, and two sixteenths in width: spire elevated: marked with numerous thread-like lines: aperture orbicular.

Turbo Thomsonianus resembles *T. Mancuniensis* in form; but it is a smaller species, and its whorls are marked with numerous spirally-arranged thread-like lines,—not ridges. It has been ornamented with transverse coloured bands.

This species is of rare occurrence in the Shell-limestone at Tunstall Hill, and in the Breccia at the north end of Black Hall rocks.

TURBO TAYLORIANUS,[1] *King*. Plate XVI, figs. 25, 26.

Diagnosis.—As wide as it is high: tumid: marked with numerous thread-like lines: aperture orbicular: spire depressed.

This species differs from the last in being decidedly more tumid; both agree, however, in possessing numerous fine spirally-arranged striæ. It stands in the same relation to *Turbo Thomsonianus* as *T. helicinus* does to *T. Mancuniensis*. My largest specimen is three sixteenths of an inch in height, and the same in width.

Turbo Taylorianus occurs at Tunstall Hill, and Humbleton Quarry, in Shell-limestone.

The following ten species have a very doubtful connexion with the genera in which they are placed; and most of the genera themselves are equally as doubtful as regards the families to which they belong.

Genus *Rissoa*, Fréminville and Desmarest, 1814.

Being unacquainted with the original diagnosis, and the typical species of this genus, I am compelled to waive all remarks on it, merely referring the reader to the generic character and observations of the group by Mr. Searles Wood, in his 'Monograph of the Crag Mollusca,' part i, p. 100.

RISSOA OBTUSA, *Brown*. Plate XVI, fig. 18.

(?) SMOOTH SHELL, *Sedgwick*. Trans. Geol. Soc. Lond., 2d series, vol. iii, p. 118, 1829.
(?) TURBO (?), *Phillips*. Loc. cit.
RISSOA OBTUSA, *Brown*. Trans. Manch. Geol. Soc., vol. i, p. 64, pl. vi, figs. 19-21, 1841.

[1] Named after the late Mr. John Brough Taylor, F.S.A., of Sunderland, who intended publishing a work descriptive of "the limestone strata on the coast" of Durham, and "of the extraneous substances deposited in them." (Vide Surtees's History of Durham, vol. i, p. 236.)

(?) Rissoa minutissima, *Brown*. Op. cit., vol. i, p. 64, pl. vi, figs. 12, 14.
— — and obtusa, *Brown*. Brown, Fossil Conchology, p. 79, pl. xxxvii*, figs. 28-30, 34-36.
— — — „ Morris, Catalogue, p. 161, 1843.
— — — „ De Verneuil, Bull. Soc. Géol. de France, 2me série, vol. i, p. 36, 1844.
— — — „ Geol. Russ., vol. i, p. 225, 1845.
— — — „ Tennant, Strat. List, p. 89, 1847.
(?) Trochus pusillus, *Geinitz*. Versteinerungen, p. 7, pl. iii, figs. 15, 16, 1848.

Diagnosis.—"Shell ovate, smooth, ventricose; spire nearly equal to the body in length, consisting of three depressed, subturreted volutions, divided by a deep suture; aperture nearly orbicular; pillar lip not reflected, but provided with a slight umbilicus at the base of the columella. Length upwards of a quarter of an inch; diameter not quite so much." (Brown.[1])

There is in one of the original specimens of this species belonging to Mr. Binney an important character, which Captain Brown seems to have overlooked, namely, a broad sinus in the upper half of the outer lip, as indicated by the incremental lines, which are represented in fig. 18, Pl. XVI. This character throws considerable doubt on the present generic position of the species; and somewhat favours the view that it belongs to the genus *Macrocheilus*.

Rissoa obtusa is recorded as occurring in the Magnesian Marls at Collyhurst (Captain Brown): it also occurs in the same formation at Bedford, ten miles west of Manchester (Binney).

Rissoa Leighi, *Brown*. Plate XVI, fig. 15.

Rissoa Leighi, *Brown*. Trans. Manch. Geol. Soc., vol. i, p. 64, pl. vi, figs. 9-11, 1839.
— — „ Fossil Conchology, p. 79, pl. xxxvii, figs. 25-27, 1841. (?)
— — „ Morris, Catalogue, p. 161, 1843.
— — „ De Verneuil, Bull. Soc. Géol. de France, 2me série, vol. i, p. 36, 1844.
— — „ Geol. Russ., vol. i, p. 225, 1845.
— — „ Tennant, Strat. List, p. 89, 1847.

Diagnosis.—"Shell smooth, oblong-ovate; spire long, consisting of four deeply divided, inflated volutions, terminating in a somewhat obtuse apex; aperture ovate, slightly contracted above, and rounded at the base; columella subumbilicated. Length one eighth of an inch; breadth one fourteenth of an inch." (Brown.[2])

"Found in the Magnesian Marl at Collyhurst, and is in Mr. Binney's cabinet."[3]

[1] Transactions of the Manchester Geological Society, vol. i, p. 118.
[2] Ibid., p. 64.
[3] Vide Brown's Fossil Conchology, p. 79.

RISSOA GIBSONI, *Brown*. Plate XVI, fig. 17.

RISSOA GIBSONI, *Brown*. Trans. Manch. Geol. Soc., vol. i, p. 64, pl. vi, figs. 15, 16, 17, 1839.

(? young) — PUSILLA, *Brown*. Op. cit., p. 63, pl. vi, figs. 6, 7, 8.

BOTH SYNONYMS. Brown, Fossil Conchology, p. 79, pl. xxxvii*, figs. 22-24, 31-33, 1841 (?).

Idem. Morris, Catalogue, p. 161, 1843.

Idem. De Verneuil, Bull. Soc. Géol. de France, 2me série, vol. i, p. 36, 1844.

Idem. Geol. Russ., vol. i, p. 225, 1845.

Idem. Tennant, Strat. List., p. 89, 1847.

Diagnosis.—"Shell smooth, oblong-ovate; spire and body of nearly equal length; spire consisting of four not very oblique, but rapidly decreasing volutions, terminating in an acute apex; suture well marked, but not deep; aperture ovate; outer lip smooth. Length not quite a quarter of an inch; breadth somewhat more than one eighth of an inch." (Brown.[1])

"Found in the Magnesian Marl at Collyhurst. In Mr. Binney's cabinet."[2]

Genus *Loxonema*, Phillips.

Diagnosis.—"Spiral, turriculated; whorls convex, their upper edges adpressed against the next above; without spiral band; mouth oblong, attenuated above, effused below, with a sigmoidal edge to the right lip; no umbilicus (?); surface covered by longitudinal threads or ridges generally arched."[3] (Phillips.)

Type, *Terebra sinuosa*, J. de C. Sowerby.

"These observations are merely provisional until the form of the aperture is more perfectly known. The shells have been placed as Melania, Rissoa, Terebra, Turritella, and Scalaria."[4]

LOXONEMA FASCIATA, *King*. Plate XVI, fig. 30.

MELANIÆ (?), *Phillips*. Sedgwick, Trans. Geol. Soc. Lond., 2d series, vol. iii, p. 118, 1829.

— „ De la Beche, Geol. Man., p. 384, 1831; Germ. Ed. p. 459, 1832; 3d Eng. Ed., p. 573, 1833.

LOXONEMA (?) UREI, *Fleming*. De Verneuil (*apud* King), Bull. Soc. Géol. de France, 2me série, vol. i, p. 35, 1844.

— — „ Geol. Russ., vol. i, p. 225, 1845.

— — „ Tennant, Strat. List, p. 89, 1847.

— FASCIATA, *King*. Catalogue, p. 13, 1848.

TURRITELLA PHILLIPSII, *Howse*. Trans. T. N. F. C., vol. i, pp. 240, 241, 1848.

— TUNSTALLENSIS „ (Variety.) Loc. cit.

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[1] Trans. Manch. Geol. Soc., vol. i, p. 64.

[2] Vide Brown's Fossil Conchology, p. 79.

[3] Palæozoic Fossils, p. 98.

[4] Loc. cit.

Diagnosis.—"A subulate, many-whorled, smooth species, with two or more dark spiral bands, crossed by others, on a light ground: its outer lip is inversely sigmoid."[1] (King.)

In form this species resembles the *Turritella Urei*, Fleming, with which I formerly identified it. *Turbonilla Altenburgensis*, Geinitz, of the German Zechstein, is a more tapering species than the present one; but both agree in the roundness of the whorls.

Loxonema fasciata is a rather variable species, some specimens being shorter than others; while the number of whorls remains the same. My largest specimen is three eighths of an inch in length.

It occurs in the Shell-limestone at Humbleton, Tunstall Hill, Hawthorn Hive, and Southwick-lane House. Professor Phillips's collection contains a specimen found at Ferry-bridge.

LOXONEMA SWEDENBORGIANA,[2] *King*.

LOXONEMA RUGIFERA, *Phillips*. De Verneuil (*apud* King), Bull. Soc. Géol. de France, 2me série, vol. i, p. 35, 1844.
— — ,, Geol. Russ., vol. i, p. 225, 1845.
— — ,, Tennant, Strat. List, p. 89, 1847.
— — ,, King, Catalogue, p. 13, 1848.
CHEMNITZIA, *Howse*. Trans. T. N. F. C., vol. i, p. 241, 1848.

Diagnosis.—Turreted: plicated longitudinally.

Imperfect specimens, about an inch in length, of a species resembling *Loxonema rugifera*, Phillips, have twice occurred to me; but through some accident, they have been mislaid: I am therefore unable to give any other than a provisional diagnosis of it.

Loxonema Swedenborgiana occurs in the Shell-limestone at Tunstall Hill, and Humbleton Quarry.

LOXONEMA GEINITZIANA, *King*. Plate XVI, fig. 31.

Diagnosis.—Minute: subulate: (?) smooth: many-whorled. *Aperture* sub-orbicular. *Whorls* flatly convex.

This species differs from *Loxonema fasciata*, which it otherwise resembles, in being smaller, and in having the whorls flatter, and the suture shallower. A specimen, measuring a quarter of an inch in length, has eight whorls.

Loxonema Geinitziana is a rare fossil in the Shell-limestone at Humbleton Hill. I have seen a specimen which was found at Nosterfield.

It is cited in Professor Sedgwick's Memoir (Trans. Geol. Soc. Lond., 2d series, vol. iii, p. 118) from Professor Phillips's MSS., that "five species of Melaniæ (?) less than half an inch long, with eight whorls" occur at Hawthorn Hive: perhaps the number is overstated through some error.

[1] Catalogue, p. 13.

[2] Named after Emanuel Swedenborg, one of the earliest authors who noticed the Permian Reptile—*Protorosaurus Speneri*, Meyer.

Genus *Macrocheilus*, Phillips.

This is a provisional genus typified with the so-called *Buccinum breve* of Sowerby.

The following shell is placed in the genus, because it appears to have some resemblance to certain species stationed in it by Professor Phillips; though it must be confessed, that there is just as much reason for placing it in *Phasianella*.

MACROCHEILUS SYMMETRICUS, *King*. Plate XVI, figs. 32, 33.

MACROCHEILUS SYMMETRICUS, *King*.			De Verneuil, Bull. Soc. Géol. de France, 2me série, vol. i, p. 35, 1844.
—	—	,,	Geol. Russ., vol. i, p. 225, 1845.
—	—	,,	Tennant, Strat. List, p. 89, 1847.
—	—	,,	King, Catalogue, pp. 12, 13, 1848.
EULIMA SYMMETRICA		,,	Howse, Trans. T. N. F. C., vol. i, p. 241, 1848.

Diagnosis.—"Fusiform: smooth. *Whorls* slightly rounded. *Mouth* oval, more rounded in front than behind, and a little more than a third of the shell in length."[1] (King.)

This species resembles some of the shells identified with the *Buccinum acutum* of J. Sowerby. A specimen, figured by Professor Phillips in the 'Geology of Yorkshire' (vol. ii, pl. xvi, fig. 11), has a close similarity to it: in the Permian fossil, however, the spire is a little more produced. My largest specimen measures three quarters of an inch in length.

It is of rare occurrence in the Shell-limestone at Tunstall Hill, and Humbleton Quarry.

Genus *Euomphalus*, J. Sowerby.

Diagnosis.—"An involute compressed univalve; spire depressed on the upper part; beneath concave, or largely umbilicated. Aperture mostly angular."[2] (J. Sowerby.)

EUOMPHALUS PERMIANUS, *King*. Plate XVII, figs. 10, 11, 12.

Diagnosis.—Minute: twice as wide as it is high: smooth: flatly convex on the upper side. *Umbilicus* rather large. *Aperture* suborbicular; slightly pressed in by the body whorl.

Euomphalus Permianus is a very minute species: my largest specimen does not exceed one sixteenth of an inch in width. At first I took it for the young of a Pleurotomaria; but was soon convinced of its belonging to a distinct genus, as none

[1] Catalogue, p. 12.

[2] Mineral Conchology, vol. i, p. 97.

of my specimens, of which I collected several, display the least indication of a slit in the outer lip. Its flattened apex, and rather large umbilicus, are characters readily separating it from any of the Gasteropods next to be described.

It is rather common in Shell-limestone at Tunstall Hill.

Family Naticidæ, Forbes, 1838.

The animal of this family is "peculiar for having a large foot, in which the hemispherical shell is imbedded, and which is much produced in front, beyond its edge: the tentacles are small, sometimes obliterated, and the mouth is hid in a groove: the operculum is spiral."[1]

Genus *Natica*, Adanson, 1757.

Diagnosis.—"Shell generally thick, strong, smooth, and glossy, occasionally covered with fine striæ, of an ovate, globulous, or subspheroidal form, with a short or slightly elevated spire; aperture oval, or semilunate; outer lip plain and simple; inner lip sometimes depositing a callosity, the callus modifying the form and size of the umbilicus." (Searles Wood.[2])

Natica minima, *Brown*. Plate XVI, fig. 29.

Natica minima, *Brown*. Trans. Manch. Geol. Soc., vol. i, p. 64, pl. vi, figs. 22-24, 1841.
— — „ Morris, Catalogue, p. 153, 1843.
— — „ De Verneuil, Bull. Soc. Géol. de France, 2me série, vol. i, p. 34, 1844.
— — „ Geol. Russ., vol. i, p. 225, 1845.
— — „ Tennant, Strat. List, p. 89, 1847.

Diagnosis.—"Shell ovate; body large; spire small, consisting of two depressed volutions; aperture semilunar." (Brown.[3])

This very minute species, the typical specimen (a rather imperfect cast) of which does not exceed one sixteenth of an inch in height, was found by Mr. E. W. Binney in the Permian Marls near Manchester.

Natica Leibnitziana, *King*. Plate XVI, figs. 27, 28.

Natica Leibnitziana, *King*. Catalogue, p. 13, 1848.
Littorina minima (Natica id.), *Brown*. Howse, Trans. T. N. F. C., vol. i, p. 240, 1848.
Natica Hercynica, *Geinitz*. Versteinerungen, p. 7, pl. iii, figs. 11-13, 1848.

Diagnosis.—As wide as it is high: rather thick: marked with zig-zag coloured bands in the direction of the incremental laminæ, which are oblique to the axis of the

[1] Gray, Synopsis of the British Museum, p. 91, 1841.
[2] Monograph of the Crag Mollusca, part i, p. 140.
[3] Trans. Manchester Geol. Soc., vol. i, p. 64, 1841.

shell, and somewhat prominent. *Spire* conical, but rather flattened at the apex. *Whorls* tumid, rapidly increasing in size, and distinctly separated from each other. *Aperture* orbicular; with the inner lip slightly overspreading a narrow canaliculate umbilicus.

My largest specimen of this pretty species measures nearly half an inch in width, and the same in height. It differs in the form of its aperture from the last species, which is also more elongated, and much smaller.

Natica Leibnitziana is a rare species in Shell-limestone at Tunstall Hill, and Silksworth. Dr. Geinitz states that Herr Mielecki has discovered it in Zechstein-dolomite in the neighbourhood of Osterode; and at Scharzfeld, and Sachswerfen, in the Hartz.

Family Pleurotomariidæ,[1] King.

The present group is proposed for the genera *Pleurotomaria*, *Trochotoma*, *Murchisonia*, and *Schizostoma*, which are furnished with a fissure in the outer lip, or a row of small apertures in the body-whorl, for the purpose of carrying off the vitiated currents from the branchial chamber.

It has existed nearly throughout all organic time, being found in certain of the Silurian rocks, and still an inhabitant of the present seas. The next genus is the only one known to occur in the Permian deposits of Britain.

Genus *Pleurotomaria*, De France.

(?) Anatomus,[2] *De Montfort*, 1810.
Scissurella, *A. d'Orbigny*, 1823.

Diagnosis.—"Shell spiral, turbinated, sometimes quite conical, and having either a nearly square or somewhat rounded aperture, generally, however, of a sub-quadrate form; the outer lip being sharp-edged; and having near its upper edge a deep notch or fissure near the suture."[3]

The genus *Pleurotomaria* was simply indicated by M. de France, in vol. xli of the 'Dictionnaire des Sciences Naturelles,' in which it is divided into two sections,—the umbilicated and non-umbilicated. The first section is typified with *Pleurotomaria tuberculosa*, and the second with *Pleurotomaria elongata*. These and some other sections

[1] Vide King, Catalogue, p. 13.

[2] It is much to be regretted, that nothing more seems to be known of this singular genus than what is published of it by Montfort. (Vide 'Conchyliologie Systématique,' t. ii, pp. 279, 280.) If I am correct in the view herein taken of the habit of *Pleurotomaria* (vide p. 215), *Anatomus* cannot be a synonymous genus; since Montfort states, that he saw a large number attached to the stems and leaves of a floating sea-weed (a species of *Sargassum*) by a corneous thread ("une espèce de muscle, en partie corné"), which passed out of the notch in the lip of the aperture. *Anatomus* appears like a minute *Schizostoma*.

[3] Sowerby's Genera.

have been elevated to the rank of genera by some authors, which is probably correct; but in the absence of the necessary data, I am compelled to adopt the present genus as it was left by its founder, and to include in it the following four species.

I have made D'Orbigny's *Scissurella* synonymous with *Pleurotomaria*, in consequence of not being able to perceive any generic difference between the recent British *Scissurella crispata*,[1] Fleming, and such shells as the Permian *Pleurotomaria antrina*.

With regard to the fissure in the lip of the aperture of *Pleurotomaria*, I am of opinion, that it is for the purpose of carrying off fæcal matter and the vitiated currents. In all the spiral branchiferous Gasteropods, currents of water flow into the branchial chamber, on the columella side of the aperture, and pass out on the sutural side. This may be readily seen, by examining, in a vessel of water, living specimens of such shells as *Paludina achatina* and *Trochus crassus*. The animal of these shells has each side of its body furnished with a flap-like process, which can become folded up in the form of a siphon,—the one on the columella side serving as an ingress passage, and the other on the sutural side, as an egress passage. In most of what are termed the Holostomatous Gasteropods, there is no indication of these passages in the lip of the aperture of the shell; but in the Solenostomatous division, the ingress passage is indicated by a canaliculate prolongation at the lower portion of the aperture, corresponding with a correspondingly formed process of the mantle; and the egress passage is occasionally indicated, as in *Pleurotoma*, *Clavatula*, and some other genera, by the sutural side of the lip being sinuated, or notched. In *Triphoris*, what are taken for the ingress and egress openings are respectively a canaliculate orifice at the base of the shell, and a circular perforation contiguous to the suture and near the margin of the outer lip. In the exceptional genera of the Holostomatous Gasteropods, such as *Haliotis* and its allies, only one of the passages is indicated,—the row of perforations, or emargination of the lip of the aperture, from the immediately subjacent position of the rectum, being clearly for the eduction of the rejected water and other matter. The same is suspected to be the use of the sinus with which the lip is furnished in certain species of *Ianthina*; of the deep sutural notch in an American genus of *Melaniidæ*; and of the closed spiniferous fissure of *Clithon corona*, (*Nerita id.*, Linn.) The notch of *Emarginula*, the perforation of *Fissurella*, and the siphon of *Rimula*, are well known to be subservient to carrying off the egress currents. It will thus be evident, that the fissure on the sutural side of the aperture of *Pleurotomaria* has served as an outlet for the vitiated water passing off from the branchial chamber.

[1] Having carefully examined some of the original specimens of *Scissurella crispata* got by Dr. Fleming at Noss in Zetland, and at present in Mr. Jeffreys's superb collection of British shells, I feel convinced, that this species is a living representative of the genus *Pleurotomaria*. Mr. G. B. Sowerby states, that he has seen specimens of a tertiary *Scissurella* collected at Grignon, in which "the margin of the lip is entire, and an oblong foramen reaches very nearly to the edge, but not quite." I suspect that the lip only becomes entire in full-grown specimens.

Pleurotomaria, considering that living specimens of a species have been dredged in deep water off Lerwick in Shetland, "adhering to stones like *Emarginula*,"[1] it may be concluded to be a ground-dwelling genus: it consequently differs from *Ianthina*—by some supposed to be an allied genus—which is essentially an ocean-surface inhabitant.

No evidence has yet come to light proving that any species are perlaceous,—a circumstance, which, viewed in connexion with the histology of the shell of *Pleurotomaria crispata* (*Scissurella id.*, Flem.), is strongly in favour of the genus being essentially non-perlaceous.

Pleurotomaria appears to have existed from nearly the earliest portion of organic time to the present moment; but the species have evidently decreased in dimensions, and numerical amount during the Tertiary and existing periods.

PLEUROTOMARIA ANTRINA, *Schlotheim*. Plate XVII, figs. 1, 2, 6.

TROCHILITES ANTRINUS, *Schl.* Akad. Münch., vol. vi, p. 32, pl. vii, fig. 6 *c* (? not *a*, *b*), 1816.

(?) PLEUROTOMARIA (?), *J. de C. Sow.* Sedgwick, Trans. Geol. Soc. Lond., 2d series, vol. iii, p. 118, 1829.

(?) — (?) ,, Phillips, Encyc. Met., vol. iv, p. 618, 1834.

— ANTRINA, *Schl.* Geinitz, Gæa von Sachsen, p. 95, 1843.

— CARINATA, *J. Sow.* De Verneuil (*apud* King), Bull. Soc. Géol. de France, 2me série, vol. i, p. 34, 1844.

— — ,, Geol. Russ., vol. i, p. 225, 1845.

— — ,, Tennant, Strat. List, p. 89, 1847.

— PERMIANA, *King*. Catalogue, p. 13, 1848.

— SEDGWICKIANA, *Howse*. Trans. T. N. F. C., vol. i, p. 238, 1848.

— — , var. AMPULLA, *Howse*. Op. cit.

— ANTRINA, *Schl.* Geinitz, Versteinerungen, p. 7, pl. iii, fig. 19 *a*, *b*, 1848.

(?) — VERNEUILI, *Geinitz*. Op. cit., p. 7, pl. iii, figs. 17 *a*, *b*, 18 *a*, *b*. *c*, 1848.

Diagnosis.—"Short: conical. *Whorls* rounded; marked with distinct, tolerably regular, incremental striæ. *Fissure-band* broad; bounded on both sides by a narrow line."[2]

"This species resembles the *Pleurotomaria carinata* of J. Sowerby, with which I formerly identified it; but it has a concave sinus-band and a small umbilicus: its colouring consists of straight and not zig-zag longitudinal bands, as in the latter: it is spirally threaded, and its pillar-lip is perpendicular."[3] The specimen represented by fig. 19, pl. iii, in the 'Versteinerungen,' is more distinctly marked with lines of growth than any that have occurred to me. Occasionally specimens are found with the spire

[1] Vide Jeffreys, Annals and Magazine of Natural History, 2d series, vol. iv, p. 300.

[2] Vide Geinitz, 'Versteinerungen,' p. 7. "Ein kurz-kegelförmiges Gewinde von vier stark gewölbten Umgängen, in deren Mitte eine breite Spaltdecke von zwei schmalen Leisten begränzt wird. Die ganze Schale ist mit deutlichen, ziemlich regelmässigen Zuwachstreifen verziert."

[3] King, Catalogue, p. 13.

unusually produced, and the upper half of the whorls flattened, as exampled in the specimen represented by fig. 6, Pl. XVII; in these respects it agrees very closely with Dr. Geinitz's *Pleurotomaria Verneuili:* the specimen of the latter represented in the 'Versteinerungen,' pl. iii, fig. 18 *a*, *b*, *c*, however, appears to have a wider umbilicus. My largest specimen is five eighths of an inch in height axially.

Pleurotomaria antrina is rather common in some places; for example, Tunstall Hill, and Silksworth, in Shell-limestone; but somewhat rare at Humbleton Quarry, Castle Eden-Dene, and Dalton-le-Dale, in the same rock; and extremely rare at Tynemouth-Castle Cliff in the Breccia. According to Dr. Geinitz, it occurs in the Zechstein-dolomite at Glücksbrunn and Könitz; and according to Credner, near Asbach and Schmalkalden.

PLEUROTOMARIA TUNSTALLENSIS, *King*. Plate XVII, figs. 3, 4, 5.

PLEUROTOMARIA TUNSTALLENSIS, *King*. Catalogue, p. 14, 1848.

Diagnosis.—Conical. *Whorls* evenly rounded; marked with fine spiral lines, and slight incremental striæ. *Aperture* sub-orbicular: with the pillar-lip oblique. *Fissure* deep, and situated in the medio-longitudinal part of the whorls.

This species resembles the last in form; but it is non-umbilicated, and its pillar-lip is oblique: it is also related to *Pleurotomaria striata*, J. Sow.; but instead of the umbilicus being closed by a somewhat thick and a rather broad callosity, which is the case with the latter, according to De Koninck, it is without any callosity, and its pillar-lip is sharp, though a little reflexed. The apical whorls are occasionally transversely plicated near the suture; as displayed in the enlarged representation at fig. 5, Pl. XVII.

Although this and the preceding shell have been specifically separated, I have considerable doubts as to their really being distinct,—or, perhaps, it would be better to say, that I feel considerable difficulty in separating them: whether this is owing to there being no specific difference between them, or to their closely simulating each other, I am certainly not much disposed to contend for: if, however, it be necessary to unite them, it will almost be impossible, from their various modifications, to draw up any other than a very general diagnosis of the species. My largest specimen measures a quarter of an inch in its axial length.

Pleurotomaria Tunstallensis occurs at Tunstall Hill in Shell-limestone; but not so often as the last species.

PLEUROTOMARIA NODULOSA, *King*. Plate XVII, fig. 9.

PLEUROTOMARIA NODULOSA, *King*. De Verneuil, Bull. Soc. Géol. de France, 2me série, vol. i, p. 35, 1844.
— — ,, Geol. Russ., vol. i, p. 225, 1845.
— — ,, Tennant, Strat. List, p. 89, 1847.
— — ,, King, Catalogue, p. 14, 1848.
— — ,, Howse, Trans. T. N. F. C., vol. i, p. 238, 1848.

Diagnosis.—"Spirally threaded, the threads crossed with rather strong lines of growth: with two spiral rows of tubercles, one situated immediately below the sinual band, and the other close to the suture: the sinual band is concave, and furnished with a mesial thread." (King.[1])

This, the prettiest species of the genus belonging to the Permian system, is readily distinguished by its prominent decussated sculpturing, and its two rows of wave-like nodules, one adjoining the suture, and the other below the line of the fissure-band. It is decidedly umbilicated, and has a sharp slightly-reflexed perpendicular pillar-lip. The spiral or longitudinal lines are stronger than the incremental striæ, and the lip on each side of the fissure is rounded. My largest specimen measures five eighths of an inch axially.

Pleurotomaria nodulosa is an exceedingly rare species, having occurred to me but very seldom at Tunstall Hill and Humbleton Quarry, in Shell-limestone.

Pleurotomaria Linkiana, *King*. Plate XVII, figs. 7, 8.

Pleurotomaria Permiana, *King* (*partim*). Catalogue, p. 13, 1848.
— penea, *De Verneuil*. Howse, Trans. T. N. F. C., vol. i, p. 238, 1848.

Diagnosis.—Umbilicated: twice as wide as it is high. *Spire* depressed. *Whorls* evenly rounded: marked with rather prominent spiral lines.

This species differs from both *Pleurotomaria antrina*, and *P. Tunstallensis*, in having the spire decidedly more depressed; and from M. de Verneuil's *Pleurotomaria penea*, in having the whorls evenly rounded, and not medio-longitudinally carinated. The specimen figured is a quarter of an inch wide, and an eighth of an inch high.

Pleurotomaria Linkiana is a rare species: it has occurred to me only at Humbleton Hill and Dalton-le-Dale, in Shell-limestone.

Order Cirrhobranchiata, *De Blainville*.

Family Dentaliidæ, Sander Rang.

Genus *Dentalium*, Linnæus, 1740.

Diagnosis.—"Shell tubular, symmetrical, elongato-conical, or sub-cylindrical, generally smooth; sometimes annulated, often costated; slightly curved, open at both ends; smaller at the posterior extremity, which is sometimes entire, sometimes with a medial and dorsal cleft, occasionally with two lateral indentations." (Searles Wood.[2])

[1] Catalogue, p. 14.
[2] Monograph of the Crag Mollusca, p. 187.

The reader is referred to M. Deshayes's Monograph of *Dentalium*, and to a paper by Mr. W. Clark,[1] for an account of the mollusk of this genus.

Dentalium Sorbii, *King*.

Diagnosis.—Smooth; curved; gradually tapering.

The above is a provisional description of a species supposed to be of the present genus. It was discovered by Mr. Henry Clifton Sorby, F.G.S., who has only succeeded in finding a single specimen, which is not quite perfect at the small end. The specimen appears to have been about five eighths of an inch in length; and its curvature is about the same as a circle, the radius of which is from half to five eighths of an inch.

Dentalium Sorbii occurs at Connigsborough, near Doncaster.

Class Cephalopoda, Cuvier, 1798.

Cephalophora, *Blainville*.

Diagnosis.—"A class of molluscous invertebrate animals, in which the head is situated between the trunk and the feet, or principal organs of locomotion." (Owen.[2])

"The Cephalopods have been divided into two sections, depending on their having two, or four gills: those with two gills are termed Dibranchians, and such as have four, are called Tetrabranchians. The Calamary, Cuttle-fish, Argonaut, and Spirula are examples of the dibranchiate, and the Pearly Nautilus represents the tetrabranchiate section."[3] The latter is the only division known as having representatives in the Permian system.

Order Tetrabranchiata, Owen.

This group contains at least two families, *Nautilidæ* and *Ammonitidæ*, both consisting of chambered shells; but the former has the septa or partitions, separating the chambers, generally plain at the margins, and perforated centrally or sub-marginally; whereas the latter has the plates variously lobed at the margins, and perforated marginally at the medio-dorsal line of the shell.

Family Nautilidæ (*Nautilles, restricted*), Cuvier.

Diagnosis.—"Shell external, spiral, or straight; septa smooth and simple; the last

[1] Annals and Magazine of Natural History, 2d series, vol. iv, p. 321.

[2] Cyclopædia of Anatomy, vol. i, p. 517.

[3] Vide the author's paper entitled "An attempt to classify the Tetrabranchiate Cephalopods," in the Ann. and Mag. of Nat. Hist.,' vol. xiv, p. 272.

chamber the largest, and containing the animal: siphon central, or marginal and internal." (Owen.[1])

This is the only known Permian Tetrabranchiate family.

Genus *Nautilus*, Linnæus.

Diagnosis.—"Shell discoid, spiral, multilocular, with simple walls. *Whorls* contiguous, the last whorl enveloping the others. *Chambers* numerous, formed by transverse partitions, which are concave towards the side facing the aperture: they are perforated by a tube, and their edges are simple."[2] (Lamarck.)

This is the longest-lived genus of testaceous Cephalopods. It has existed from the earliest organic age to the present time,—seeming to be scarce in species during one period, and numerous in another: at present, it is represented only by the three species, *Nautilus Pompilius*, *N. umbilicatus* and *N. virgatus*,—which are confined to the Southern Ocean.[3]

Nautilus Freieslebeni, *Geinitz.* Plate XVII, figs. 13, 14, 15, 16, 20.

(?) Ammonites,[4] *Sedgwick.* Trans. Geol. Soc. Lond., 2d series, vol. iii, p. 118, 1829.
(?) — „ Proceedings of the Geological Society, vol. i, p. 204.
Nautilus „ *Phillips*, Lardner's Cyclop., Geology, vol. i, p. 190, 1837.
— Freieslebeni, *Geinitz.* Neues Jahrbuch, p. 637, pl. xi, fig. 1, 1841.
— — „ Gæa von Sachsen, p. 95, 1843.
— — „ De Verneuil, Bull. Soc. Géol. de France, 2me série, vol. i, p. 36, 1844.
(?) Ammonites (?) *Sedgwick.* Op. cit.
— „ Geol. Russ., vol. i, p. 226, 1845.
Nautilus Freieslebeni, *Geinitz.* Op. cit.
— — „ King, Catalogue, p. 14, 1848.
— — „ Howse, Trans. T. N. F. C., vol. i, p. 237, 1848.
— — „ Versteinerungen, p. 6, pl. iii, fig. 7 *a*, *b*, *c*, 1848.

Diagnosis. Whorls slightly increasing in size; with a broad flatly-rounded back; marked with delicate incremental striæ. *Septa* slightly sinuated at the sides. *Aperture* somewhat squared, having the greatest diameter from side to side. *Siphonal sheath* situated in the inner third of the septa.[5]

[1] Cyclopædia of Anatomy, loc. cit.

[2] Animaux sans Vertèbres. The following is the diagnosis published by Linnæus: "Testa univalvis, isthmus perforata concamerata, polythalamia."

[3] For a description of the animal of Nautilus, see Professor Owen's 'Memoir on the Pearly Nautilus;' 'Lectures on Comparative Anatomy,' vol. i; and the article 'Cephalopoda,' in the 'Cyclopædia of Anatomy,' vol. i.

[4] Vide Appendix.

[5] "Die Stärke der Windungen nimmt nicht bedeutend zu, der Rücken ist breit gerundet, die Kammerscheidewände bilden an den Seiten einen sehr schwachen Sinus. Die Mündung ist etwas höher als ein an

In this species the outer chamber or that which has been tenanted by the animal is long; as shown by the complete cast of it, represented in Pl. XVII, fig. 14: the whorls increase rather slowly in width; and are flatly rounded at the back and sides: the siphonal sheath is large, continuous, and excentrically situated,—passing through the septa nearest their inner margin (vide Pl. XVII, figs. 14, 15 *a*, fig. 16 *a*): the septa are slightly undulated at the margins: the sides of the aperture are a little prolonged beyond the medio-dorsal region, which is sinuated (vide Pl. XVII, figs. 13, 14): and the whorls slightly embrace each other. *Nautilus concavus*, J. de C. Sowerby, of the Carboniferous system, appears to be a closely related species.[1]

Nautilus Freieslebeni occurs in Shell-limestone at Humbleton Quarry, Tunstall Hill, Silksworth, Dalton-le-Dale; and in the compact beds at Whitley Quarry. Professor Phillips possesses a specimen which he collected at Aldfield, Yorkshire. It is found, according to Dr. Geinitz, in the under Zechstein of Milbitz, and Röpsen near Gera, Corbusen near Ronneburg, and Ilmenau in the Thuringerwald.

Nautilus Bowerbankianus,[2] *King*. Plate XVII, figs. 17, 18, 19.

Diagnosis.—Deeply umbilicated. *Whorls* increasing rather rapidly in size; slightly embracing each other; evenly and continuously rounded on the back and sides between the latero-ventral angles; decussated superficially with incremental striæ, and numerous fine raised longitudinal lines. *Aperture* somewhat orbicular: *margin* rounded at the sides, and sinuated medio-dorsally.

This beautiful species is readily distinguished from the last, in having its dorsal and lateral surfaces evenly and continuously rounded, in the whorls increasing more rapidly in size, and in the more rounded form of its aperture. From certain markings, which *appear* to be due to the plates, I am led to *suspect*, that these structures have their margin concave at the sides of the whorls, and pointed at the medio-dorsal line; as in the carboniferous *Nautilus clitellarius*,[3] which the present species somewhat resembles in form.

Nautilus Bowerbankianus is a rare fossil, having but once occurred to me at Tunstall Hill in Shell-limestone, and at the north end of Black Hall rocks in a brecciated and probably equivalent deposit.

den Hörnern gerundeter Halbmond. Der Sipho liegt in einem Drittheile der Höhe von der Bauchseite an, in deren Mitte die Kammerwand eine kleine einspringende Vertiefung bildet. Die dünne Schale zeigt zarte Zuwachsstreifen, welche sich auf dem Rücken in einen breiten und tiefen Sinus herabbiegen."—Versteinerungen, p. 6. The diagnosis in the text is slightly altered from the above.

[1] Trans. Geol. Soc. Lond., 2d series, vol. v, pl. xl, fig. 6.

[2] I feel much pleasure in naming this species after Mr. J. S. Bowerbank, to whom I am under deep obligations for numerous emendations in the present work, during its progress through the press.

[3] Transactions of the Geological Society of London, 2d series, vol. v, pl. xl, figs. 5, 5 *b*.

Sub-kingdom VERTEBRATA, Cuvier.

Of the present division of Animated Nature, Fishes and Reptiles are the only groups requiring notice in this Monograph; since no remains of Birds and Mammals have yet been found in deposits belonging to the Permian period.

Class Pisces, Linnæus.

According to the system of Agassiz, this class consists of four orders, namely, *Placoidei*, *Goniolepidoti*, *Ctenoidei*, and *Cycloidei*. Of these, the first two alone require consideration in this Monograph, as all the Ichthyolites of the Permian age are referable to them.

Order Placoidei, Agassiz.

Plagiostomi, *Cuvier.*

Family Cestraciontidæ, Agassiz.

Genus *Gyracanthus*, Agassiz.

Gyracanthus formosus, *Agassiz.*

Petrified wood, *Ure.* History of Rutherglen, pp. 303, 304, pl. xii, fig. 6.
A remarkable fossil,[1] *J. de C. Sowerby.* Zoological Journal, vol. ii, pp. 252, 253, pl. viii, fig. 9.
Gyracanthus formosus, *Agassiz.* Poissons Fossiles, vol. iii, p. 17, pl. v, figs. 4-8.
— — „ King, Catalogue, p. 14, 1848.
— Howse, Trans. T. N. F. C., vol. i, p. 237, 1848.

"The Newcastle Museum possesses a fragment of a fossil, which I am happy in making out to be an Ichthyodorulite or dorsal spine of an extinct family of sharks. It is the impression of the inferior part of the anterior face, showing the entire length of the root and a small portion of the obliquely ridged part: the root is longitudinally striated, and the obliquely ridged part tapers off to a point on the mesial line of the anterior face: the point is an inch and a quarter from the termination of the root. I feel persuaded that it is the *Gyracanthus formosus*."[2]

[1] Mr. Sowerby adds, "most probably belonging to a Fish."
[2] King, Catalogue, p. 14.

The specimen alluded to, the only one that has been procured, was found in the Lower New Red Sandstone near Westoe, by Mr. William Hutton, to whose unceasing labours, as Honorary Secretary, the high standing of the Newcastle Museum is to be chiefly attributed.

Genus *Gyropristis*, Agassiz.

Gyropristis obliquus, *Agassiz*.

Gyropristis obliquus, *Agassiz*. Poiss. Foss., vol. iii, p. 177.
— — „ Report 13th Meeting Brit. Assoc., p. 198, 1844.
— — „ De Verneuil, Bull. Soc. Géol. de France, 2me série, vol. i, p. 38, 1844.
— — „ Geol. Russ., vol. i, p. 226, 1845.

This Ichthyodorulite is stated to be from the Magnesian Limestone near Belfast; but it is doubtful whether the rock in which it was found belongs to the Permian, or to the Triassic system.

Order Goniolepidoti, Agassiz.

Family Lepidostei, Agassiz.

Genus *Palæoniscus*, Agassiz.

Clupea, *Blainville*.
Palæothrissum, *Blainville*.
Palæoniscum, *Agassiz*, 1833.

The occurrence of fishes, belonging to this genus, in the Permian Marl Slate of England, was first made known by the Memoir of Professor Sedgwick, published in the 'Transactions of the Geological Society of London,' 2d series, vol. iii, p. 37. M. de Blainville, to whom the original specimens were submitted, recognised their affinity to the fishes from the Kupfer-schiefer, arranged by him under the genus *Palæothrissum*, and considered two species as identical with those found in this formation. The more extensive researches of Professor Agassiz in this department of palæontology enabled him, on his visit to England in 1834, to detect discrepancies which had escaped M. de Blainville's observation, and consequently to establish no less than five new species of this genus from the Marl Slate of the North of England. The descriptions of these species, published in the 'Poissons Fossiles,' are so copious and so accurate, that the reader is referred to that work for the details of the specific characters.—P. G. E.[1]

[1] The passages bearing these initials are contributed by Sir Philip Grey Egerton.

PALÆONISCUS COMTUS, *Agassiz*. Plate XXI, fig. 1 *a*, *b*.

PALÆOTHRISSUM MAGNUM, *Blainville*.			Trans. Geol. Soc. Lond., 2d series, vol. iii, p. 117, pl. viii, figs. 1, 2, 1829.
—	MACROCEPHALUM, *Blainville*.		Op. cit., pl. ix, fig. 2.
—	—	,,	Phillips, Encyc. Met., Geology, vol. vi, p. 610, pl. iii, fig. 9, 1834.
PALÆONISCUS COMTUS, *Agassiz*.			Poissons Foss., vol. ii, pl. x *b*, figs. 1-3.
—	—	,,	Ann. and Mag. Nat. Hist., vol. vii, p. 494, 1841.
—	—	,,	Morris, Catalogue, p. 200, 1843.
—	—	,,	Report 13th Meeting Brit. Assoc., p. 198, 1844.
—	—	,,	De Verneuil, Bull. Soc. Géol. de France, 2me série, vol. i, p. 38, 1844.
—	—	,,	Geol. Russ., vol. i, p. 226, 1845.
—	—	,,	Tennant, Strat. List, p. 89, 1847.
—	—	,,	King, Catalogue, p. 14, 1848.
—	—	,,	Howse, Trans. T. N. F. C., vol. i, p. 231, 1848.

This species of *Palæoniscus* was considered by M. de Blainville to be identical with the *Palæothrissum magnum* of the Kupfer-scheifer; but Agassiz has pointed out the following distinctive characters. The upper and lower margins of the scales are arched, and the scales themselves on the flanks are comparatively much deeper and longer than those of the caudal region. In *Palæoniscus magnus* the margins are straight; the scales nearly equilateral, and of more uniform dimensions. The other characters are well defined in the 'Poissons Fossiles,' and easily appreciable.—P. G. E.

Palæoniscus comtus is the most abundant fish of the Permian system of England, having been found wherever the Marl-slate is exposed, as at East Thickley, Midderidge, Ferry-Hill, Houghton-le-Spring, Whitley, Cullercoats, West Bolden, Brussleton, and other places. The specimen selected for illustration, which is in a rare and beautiful state of preservation, was found in the dark bituminous shale at Thrislington Gap.

PALÆONISCUS ELEGANS, *Sedgwick*. Plate XXII, fig. 1 *a*.

PALÆOTHRISSUM ELEGANS, *Sedgwick*.			Trans. Geol. Soc. Lond., 2d series, vol. iii, p. 117, pl. ix, fig. 1, 1829.
—	—	,,	Phillips, Encyc. Met., Geology, vol. vi, p. 619, 1834.
PALÆONISCUS	—	,,	Agassiz, Poiss. Foss., vol. ii, p. 95, pl. x *b*, figs. 4, 5.
—	—	,,	Annals and Mag. Nat. Hist., vol. vii, p. 495, 1841.
—	—	,,	Morris, Catalogue, p. 208, 1843.
—	—	,,	Report 13th Meeting Brit. Assoc., p. 198, 1844.
—	—	,,	De Verneuil, Bull. Soc. Géol. de France, 2me série, vol. i, p. 38, 1844.
—	—	,,	Geol. Russ., vol. i, p. 227, 1845.

PALÆONISCUS ELEGANS, *Sedgwick*. Tennant, Strat. List, p. 89, 1847.
— — „ King, Catalogue, p. 14, 1848.
— — „ Howse, Trans. T. N. F. C., vol. i, p. 232, 1848.
— — „ Geinitz, Versteinerungen, p. 5, 1848.

Palæoniscus elegans is one of the rarest fishes of the Permian System. It differs from the other species of this genus in its more elegant form and well-proportioned dimensions, which fully entitle it to the specific name it has received. The head bears the proportion of one fifth of the entire length; all its component bones are ornamented with diverging furrows. The body is an elongated oval. All the fins are proportionally small: the transverse articulations of the dorsal and anal are far apart; and the rays are bifurcated for half their length. The anterior borders of these fins are furnished with a fringe of very small rays attached to the larger ones. The rays of the caudal fin are very slender, and dichotomize frequently. The transverse articulations of the upper lobe are very close together: in the lower lobe they are more distant.[1]—P. G. E.

Palæoniscus elegans occurs in Marl-slate at Midderidge, East Thickley, Whitley, Cullercoats, and Ferry Hill. The beautiful specimen figured, and now in the Newcastle Museum, was collected by myself at Aycliff in the same bed.

PALÆONISCUS GLAPHYRUS, *Agassiz*. Plate XXII, figs. 3, (?) 4 *b*.

PALÆONISCUS GLAPHYRUS, *Agassiz*. Poiss. Foss., vol. ii, p. 98, pl. x *c*, figs. 1, 2.
— — „ Ann. and Mag. Nat. Hist., vol. vii, p. 495, 1841.
— — „ Morris, Catalogue, p. 201, 1843.
— — „ Rep. of 13th Meet. Brit. Assoc., p. 196, 1844.
— — „ De Verneuil, Bull. Soc. Géol. de France, 2me série, vol. i, p. 38, 1844.
— — „ Geol. Russ., vol. i, p. 227, 1845.
— — „ Tennant, Strat. List, p. 89, 1847.
— — „ King, Catalogue, p. 14, 1848.
— — „ Howse, Trans. T. N. F. C., vol. i, p. 233, 1848.
— — „ Geinitz, Versteinerungen, p. 5, 1848.

In my 'Catalogue,' p. 14, it is stated that the Newcastle Museum possesses a specimen from the Marl-slate, Whitley (vide Pl. XXII, fig. 4), resembling the *Palæoniscus angustus* of Agassiz, but with this difference, that it has both lobes of the tail of the same length: in other respects, as the relative position of the fins, and the arrangement of the scales, it agrees with the latter. From the following observations, however, communicated to me by Sir Philip Egerton, it would appear that the specimen belongs to the present species.

"The most important features in the Whitley specimen are the position of the dorsal fin, which is placed farther back than in the other Permian species,—the

[1] This description is abridged from the more copious article in the 'Poissons Fossiles.'

smooth character of the scales, and their large size,—and the limited heterocercism of the tail. In referring to Agassiz's description of *P. glaphyrus*, I find these are the principal characters assigned to that species, combined with the dentation of the free edges of the scales. The last feature I failed to detect at first sight, in your specimen; but I have since, with a strong light, discovered two or three scales near the head, having posterior edges perfect, and showing the dentations. There remains, therefore, no doubt on my mind (although the body of the fish is certainly more slender than the one figured by Agassiz), that it is a small *P. glaphyrus*. Judging from Agassiz's figure, I think the belly scales in the York Museum specimen (vide Pl. XXII, fig. 3) are a little dislocated downwards, giving a deeper appearance to the body. In the Whitley specimen, the dislocation and elongation of the head and shoulders tend to convey the idea of more slender proportions than the Fish really possessed. Taking these points into consideration, I do not think the discrepancies sufficient to warrant the establishment of a new species."

This, which is another rare species, occurs in the Marl-slate at Midderidge, East Thickley, West Bolden, Houghton-le-Spring, Whitley, Rushyford, Ferry Hill, and Thrislington Gap. It has been found, according to Dr. Geinitz, at Mansfeld in the Kupferschiefer.

PALÆONISCUS LONGISSIMUS, *Agassiz*. Plate XXI, fig. 2 *c*.

PALÆONISCUS LONGISSIMUS, *Agassiz*.			Poiss. Foss. vol. ii, p. 100, pl. x *c*, fig. 4.
—	—	,,	Ann. Mag. Nat. Hist., vol. vii, p, 495, 1841.
—	—	,,	Morris, Catalogue, p. 201, 1843.
—	—	,,	Rep. 13th Meet. Brit. Assoc., p. 198, 1844.
—	—	,,	De Verneuil, Bull. Soc. Géol. de France, 2^{me} série, vol. i, p. 38, 1844.
—	—	,,	Geol. Russ., vol. i, p. 227, 1845.
—	—	,,	Tennant, Strat. List, p. 89, 1847.
—	—	,,	King, Catalogue, p. 14, 1848.
—	—	,,	Howse, Trans. T. N. F. C., vol. i, p. 233, 1848.

This elegant fish, so well characterised by its specific appellation, has been found in Marl-slate at East Thickley, Midderidge, West Bolden, and Houghton-le-Spring. The beautiful specimen figured, and now in the Newcastle Museum, was got out of the same bed at Thrislington Gap. The Whitby Museum contains a specimen, apparently of this species, which was found by Miss Green of South Shields in the Limestone on the coast of Durham, a little north of Marsden.

PALÆONISCUS MACROPTHALMUS, *Agassiz*. Plate XXII, fig. 2.

PALÆONISCUS MACROPTHALMUS, *Agassiz*.			Poiss. Foss., vol. ii, p. 99, pl. x *c*, fig. 3.
—	—	,,	Ann. and Mag. Nat. Hist., vol. vii, p. 495, 1841.
—	—	,,	Morris, Catalogue, p. 201, 1843.

Palæoniscus macropthalmus, *Agassiz*.			Rep. 13th Meet. Brit. Assoc., p. 198, 1844.
—	—	,,	De Verneuil, Bull. Soc. Géol. de France, 2me série, vol. i, p. 38, 1844.
—	—	,,	Geol. Russ., vol. i, p. 227, 1845.
—	—	,,	Tennant, Strat. List, p. 89, 1847.
—	—	,,	King, Catalogue, p. 14, 1848.
—	—	,,	Howse, Trans. T. N. F. C., vol. i, p. 234, 1848.
—	—	,,	Geinitz, Versteinerungen, p. 5, 1848.

The representation given of this fish is taken from the original drawing of Mr. Dinkel, made for the 'Poissons Fossiles,' and now, through the liberality of the Earl of Ellesmere, deposited in the library of the Geological Society of London. The species is distinguished by the large size of the head, the slender proportions of the body, and the small dimensions of the scales, being in all these particulars diametrically opposed to the characters of *P. glaphyrus*.—P. G. E.

Palæoniscus macropthalmus occurs at East Thickley, Midderidge, and Thrislington Gap, in Marl-slate. According to Dr. Geinitz, it occurs in the Kupferschiefer of Riechelsdorf.

Palæoniscus catopterus, *Agassiz*.

Palæoniscus catopterus, *Agassiz*.			Proceedings of the Geol. Soc., vol. ii, p. 206, 1835.
—	—	,,	Portlock, Ordnance Surv., Londonderry, App., vol. i, 1837.
—	—	,,	Poissons Fossiles, vol. ii.
—	—	,,	Portlock, Geol. Londonderry, p. 468, 1843.
—	—	,,	Morris, Catalogue, p. 200, 1843.
—	—	,,	Report, 13th Meet. Brit. Assoc., p. 199, 1843.
—	—	,,	De Verneuil, Bull. Soc. Géol. de France, 2me série, vol. i, p. 39, 1844.
—	—	,,	Geol. Russ., vol. i, p. 227, 1845.
—	—	,,	Quart. Journ. Geol. Soc., p. 4, 1849.

M. Agassiz has placed *Palæoniscus catopterus* in the Triassic system; while Sir Roderick I. Murchison and M. de Verneuil have stationed it in the Permian. It is, therefore, noticed in the present work as doubtful in regard to its geological age.

Sir Philip Grey Egerton has lately described this species in a memoir read before the Geological Society of London in the following terms:—"Although the discovery of this species in the new red sandstone of the County Tyrone was communicated to the Geological Society by Sir Roderick Murchison so long ago as 1835, yet no description of the fish has yet been published. It was assigned to the genus *Palæoniscus* by Agassiz, who very happily noted its most distinctive character in the specific appellation *catopterus*. In size it is the smallest, in form the most slender species of the genus. The head is small and more pointed than in other *Palæonisci*: the eye is placed forward; the mouth appears small; the operculum is nearly semicircular. The dorso-ventral series of scales are very regular

and distinct. The scales themselves are large, and of very uniform size over the whole body. The specimens hitherto found are not in a condition to show the superficial characters of the scales, the impressions of the under-sides alone being preserved. The dorsal fin is placed much nearer the tail than in any other species: in this respect, but in no other, *Palæoniscus catopterus* resembles the genus *Catopterus* of Mr. Redfield. The tail is decidedly heterocerque. It is altogether so distinct from the other *Palæonisci*, that it is recognisable at first sight." A slab presented to the Geological Society by Mr. Green, exhibits, on a surface not exceeding two feet square, above 250 specimens.

Palæoniscus catopterus occurs in a quarry of red sandstone at Rhone Hill, in the parish of Killyman about three miles east of Dungannon, Ireland.

Family Pycnodontidæ, Agassiz.

Genus *Platysomus*, Agassiz.

Rhombus, *Wolfart.*
Stromateus, *Blainville.*
Uropteryx, *Agassiz.*
Globulodus, *Münster.*

For the latest published account of this singular genus, and the reasons for removing it from the heterocercal Lepidoids to the present family, the reader is referred to a very admirable paper by Sir Philip de Malpas Grey Egerton, Bart., M.P., inserted in the 'Quarterly Journal of the London Geological Society,' vol. v, part i, pp. 329-332.

Platysomus macrurus, *Agassiz.* Plate XXVI, fig. 1 *a*.

Fossil fish; genus not determined, *Sedgwick.* Trans. Geol. Soc. Lond., 2d series, vol. iii, p. 118, pl. xii, figs. 1, 2, 1829.
Uropteryx undulatus, *Agassiz.* Msc. Walchner, Geol., p. 270.
Platysomus macrurus, ,, Poiss. Foss., vol. ii, p. 170, pl. xviii, figs. 1, 2.
— — ,, Morris, Catalogue, p. 202, 1843.
— — ,, Rep. 13th Meet. Brit. Assoc., p. 198, 1844.
— — ,, De Verneuil, Bull. Soc. Géol. de France, 2me série, vol. i, p. 39, 1844.
— — ,, Geol. Russ., vol. i, p. 227, 1845.
— — ,, Tennant, Strat. List, p. 89, 1847.
— — ,, King, Catalogue, p. 15, 1848.
— — ,, Howse, Trans. T. N. F. C., vol. i, p. 234, 1848.
— — ,, Egerton, Quart. Journal Geol. Soc., vol. v, part i, p. 329, fig. i, 1849.

This appears to be one of the rarest of the Fishes of the Permian System. When Agassiz was engaged upon his great work on 'Fossil Ichthyology,' he had not an opportunity of examining the then unique specimen from East Thickley, figured in the 'Transac-

tions of the Geological Society;'[1] his determination, therefore, of the species was entirely founded on the representation there given. The anterior parts of the fish are wanting, but the remainder is well preserved, and the accuracy of the drawing has enabled him to seize upon the most striking specific characters with his accustomed skill. Professor King has submitted to me a most beautiful and perfect specimen of this fish (vide Pl. XXVI), found at Ferry Hill by Mr. John Jameson of Newcastle, with a request that I would complete the specific description carried by Agassiz as far as the materials he was cognisant of would allow. This specimen is one of paramount importance; inasmuch as it reveals, for the first time, the true dentition of the genus, the knowledge of which necessitates the removal of *Platysomus* from the family of the Lepidoids to that of the Pycnodonts. The outline of the fore-part of the fish, from the insertion of the dorsal fin to the occipital crest (deficient in the East Thickley specimen), is more elegantly curved than in *P. striatus*, but from this point it is nearly perpendicular until it meets the base of the acute angle formed by the projecting jaws. This configuration is very similar to that of the corresponding parts in *Pycnodus platessus*. The upper jaw is nearly in its proper position with reference to the lower jaw; but it is rather crushed. The dentary portion of the lower jaw is composed of a dense triangular bone, very similar to the Pycnodont jaws found at Stonesfield. Being slightly inclined to one side, two rows of teeth are brought into view, the outer one containing eight or nine teeth, the inner one five, full double the size of the former. According to the formula given by Agassiz for the Genus *Pycnodus*, this fish had, in all probability, five rows of teeth in each ramus of the lower jaw. The form of the teeth is very singular. Count Münster has described a Pycnodont jaw found by Herr Althaus in the Kupferschiefer of Riechelsdorf, named *Globulodus elegans*,[2] which is furnished with teeth very similar to those in the present specimen; but the outer row alone is visible. In alluding to this genus of Count Münster, Agassiz says,[3] that it is probably founded on the dentition of *Platysomus*, a surmise which proves to be perfectly correct. The genus *Globulodus* must therefore be cancelled. The teeth of *Platysomus* are clavate in form; a circular crown, with a flattened grinding surface, being mounted on a pedicle of much less diameter, the decrease in size being effected suddenly by a deep constriction immediately below the crown. A fine sulcus circumscribes the triturating surface, apparently indicating the point of junction between the harder material of the tooth and the softer substance composing the base. No incisor teeth are visible; but it is probable from the prominence of the anterior angles of the jaws, that they were furnished with teeth of a more elongated form than those composing the masticatory apparatus. This arrangement of the dental machinery is a sufficient warrant for the removal of

[1] Trans. Geol. Soc., 2d series, vol. iii, pl. xii, fig. 1.

[2] Beiträge, &c., part v, p. 47, plate xv, fig. 7.

[3] Poissons Fossiles, vol. ii, part ii, p. 203.

Platysomus to the family of the Pycnodonts; but there are other points in the structure and form of the fish which sanction the propriety of the change. The deep and flattened form of the body induced MM. de Blainville and Germar to arrange it with the *Stromatei*, and evidently engendered a doubt in the mind of Professor Agassiz as to the validity of the zoologicial position he assigned to it. The principal structural peculiarities he so clearly points out have, he says,[1] a greater affinity to *Pycnodus* and *Gyrodus* than to *Palæoniscus* and *Caturus*. On the receipt of the Ferry Hill specimen, feeling unwilling to trust my own imperfect judgment on a point of so much importance, I informed Agassiz of the reasons which induced me to propose the alteration, and the following passage from his answer fully authorises the change :—"I quite agree with you in the propriety of combining the genus *Platysomus* with the Pycnodonts; for some time past I had indeed been impressed with the grea. difference there is between that genus and the others of the family in which it stands, and I now feel that my only reason for putting it there was the heterocercal form of tail, a character which could not fail to produce a vivid impression upon my mind when first discovered, but which I now expect to find in fishes of various families in the oldest geological ages, as well as everywhere in the youngest state of our actual fishes in their embryonic growth. The teeth, as you mention, are conclusive evidence for placing *Platysomus* with the Pycnodonts. Let me now point out to you another evidence of this relation in the form of the skeleton, especially of the apophyses before the dorsal. The specimens of *Platysomus* in the Museum in Munich show some good portions of the skeleton, and in my mind I can now compare them to the skeleton of the small *Pycnodus rhombus*, without detecting any difference. Pray institute the comparison upon a safer ground than recollection, and let me know what you find. You know under what circumstances the fossil fishes have been worked out, and as a matter of course I must expect to see daily important additions made to the edifice of which I have laid only the foundation." It is needless to go over the anatomical details so fully described in the article on the Genus *Platysomus* in the 'Poissons Fossiles;'[2] suffice it to say, that I had instituted the comparison recommended by Agassiz before I wrote to him on the subject, and had fully satisfied myself that in the generic characters it approached very closely to *Gyrodus* and *Microdon*, and only differed from the Pycnodonts hitherto known in having a decided heterocerque tail. It will be necessary for me to say a few words with reference to the 'apophyses before the dorsal,' alluded to in the above letter, since I have formed an opinion as to their nature at variance with that entertained by Agassiz. These bones are minutely described in the article on the Genus *Pycnodus*,[3] and the question is there

[1] Poissons Fossiles, vol. ii, p. 162.
[2] Ibid., p. 161.
[3] Ibid., p. 184.

proposed, whether they should be referred to the tegumentary investment, or to the internal skeleton of the fish. Agassiz advocates the latter theory, and recognises in them the analogues of the V-shaped bones in the *Clupeæ*. My reasons for thinking otherwise are as follows. In the first place, these so-called apophyses are traceable from the back to the belly, external to the vertebral column and true apophyses; secondly, they are coincident with the dorso-ventral series of scales; and thirdly, they are united to—not articulated with—the external spines or scales in front of the dorsal fin. If we examine the scales of the Pycnodonts, we shall find that they all agree in the mode of articulation, viz. in having a thick solid projecting rib on the inner anterior margin, sliced off above and below on opposite sides for forming splices with the similar processes of the adjoining scales. These splices are so beautifully adjusted, that without a magnifying power or an accidental dislocation, they are not perceptible. When *in situ* and seen internally, these continuous lines decussate with the vertebral apophyses, and cause the regular lozenge-shaped pattern so characteristic of the Pycnodonts. The Ferry-Hill specimen of *Platysomus*, and some beautiful *Gyrodi*, which I owe to the kindness of the late Count Münster, demonstrate that, as far as these genera are concerned, this is the correct solution of the problem.

Platysomus macrurus seems to have been a more robust fish than its nearest ally, *P. striatus*. The distinctive characters of the tail and the position of the fins have been well noted by Agassiz. The fin rays in this species are much stronger, and the transverse articulations more frequent. They are composed of two distinct substances, an inner bony tissue of dark colour, and an outer layer of hard enamelled substance similar to the ganoine of the scales. It is of much lighter colour than the subjacent bone, and translucent. The joints are coincident with those of the inner core, and the surface is neatly sculptured with transverse furrows. The anterior rays of the dorsal fin are supported by a series of strong flattened plates, considered by Agassiz to be sur-apophysary, rather than inter-apophysary bones. The ventral fins, so rarely preserved in this genus, are situated a little in advance of the insertion of the dorsal fin, rather nearer to the pectoral than the anal fin. The dorso-ventral series of scales, from the nape to the belly, make an elegant sigmoid flexure. The scales themselves are thicker than those of *P. striatus*, and the ornament on their surface more strongly marked, especially in the anterior part of the body. The processes by which the scales are interlocked, form, when *in situ*, the remarkable ridge discussed in the former part of this article. The outer surface of the flanks in this species seems to have been deeply fluted, in lines parallel to the dorso-ventral series of scales, at least such is the character of the impression seen in places where the scales are wanting. It is probable, from the small size of their oral aperture and the characters of their teeth, that the *Platysomi* fed either on marine plants or small shell-fish; and we see in their dense tegumentary investment, a means of protection against the aggressions of their more rapacious contemporaries; but, that even this was sometimes ineffectual we have

proof in the fact, that the *Globulodus* jaw described by Count Münster was discovered in a Coprolite!—P. G. E.

Platysomus macrurus occurs in Marl-slate at East Thickley, and Ferry-Hill. The beautiful specimen figured, originally procured by Mr. I. Jameson, and now belonging to the Newcastle Museum, was found in the latter locality.

PLATYSOMUS STRIATUS, *Agassiz*. Plate XXVII, fig. 1 *a*, *b*, *c*, *d*; Plate XXVIII, fig. 1 *a*, *b*.

FOSSIL FISH, APPARENTLY BELONGING TO THE GENUS CHÆTODON, *Winch*. Trans. Geol. Soc. Lond., vol. iv, p. 10, pl. ii, 1817.

A FLAT FISH, *Clanny*. Annals of Philosophy, vol. vi, p. 115, pl. xxxvi.

FOSSIL FISH,[1] *Sedgwick*. Trans. Geol. Soc. Lond., 2d series, vol, iii, pl. xii, figs. 3, 4, 1829.

CHÆTODON (?), *Phillips*. Encyc. Met., Geology, vol. vi, p. 619, 1834.

PLATYSOMUS STRIATUS, *Agassiz*. Poiss. Foss., vol. ii, p. 168, pl. xvii, figs. 1-4.

— PARVUS ,, Op. cit., vol. ii, p. 170, pl. xviii, fig. 3.

UROPTERYX STRIATUS ,, Msc. Walchner, Geol., p. 270.

PLATYSOMUS — ,, Ann. Mag. Nat. Hist., vol. vii, p. 496, 1841.

— — ,, Morris, Catalogue, p. 202, 1843.

— PARVUS ,, Loc. cit.

— — ,, Rep. 13th Meet. Brit. Assoc., p. 198, 1844.

— STRIATUS ,, Loc. cit.

— — ,, De Verneuil, Bull. Soc. Géol. de France, 2me série, vol. i, p. 40, 1844.

— PARVUS ,, Op. cit., p. 39.

— — ,, Geol. Russ., vol. i, p. 227, 1845.

— STRIATUS ,, Loc. cit.

— — ,, Tennant, Strat. List, p. 89, 1847.

— PARVUS ,, Op. cit.

— STRIATUS ,, King, Catalogue, p. 15, 1848.

— — ,, Howse, Trans. T. N. F. C., vol. i, p. 234, 1848.

— PARVUS ,, Op. cit.

The figure given of this species in the 'Poissons Fossiles,' pl. xvii, vol. ii, is taken from a specimen in the collection of the Earl of Enniskillen, the finest and most perfect example of the fish then known. This plate was substituted for the one originally prepared, which contained two figures, one a copy of the lithograph accompanying Professor Sedgwick's paper in the 'Geological Transactions,' the other representing a small specimen in Professor Johnston's collection. The references in the letter-press have been accidentally retained, as they were originally written, as applicable to the cancelled plate. The figure accompanying this monograph is taken

[1] Professor Sedgwick, referring to *Platysomus macrurus*, observes, that this "Fossil Fish" is "of the same genus with the preceding, but apparently of a different species." Vide Index to plate xii.

from a very perfect specimen belonging to Mr. Bowerbank, the counterpart of which is in my own collection. It gives a better idea of the outline of the species than Lord Enniskillen's specimen, as the latter has an unnatural prognathic character in consequence of the crushing in of the frontal bones. Fig. 1 of Pl. XXVIII represents a well characterised young individual of this species in the Collection of the Yorkshire Philosophical Society.—P. G. E.

"It will be seen, that I have merged *Platysomus parvus* into this species. M. Agassiz founded it on the figures given by Mr. Winch in the 'Transactions of the Geological Society,' and not on an examination of the originals: these (which are in the Sunderland Museum) I have lately inspected, and I cannot find any difference between them and an undoubted *P. striatus* in the Newcastle Museum. The draughtsman of Mr. Winch's figures has not copied the originals so closely as could be desired: he has, in consequence, incorrectly represented the dorsal and the ventral fin of the *same length*, the posterior part of the body *too round*, the head *too large*, and the root of the tail (which is injured in the originals) *too slender*."[1]

Platysomus striatus occurs at Ferry-Hill (where the beautiful specimen figured and belonging to Mr. J. S. Bowerbank was found), and Whitley, in Marl-slate. The so-called *Platysomus parvus* was found in compact Magnesian limestone at Pallion Quarry.

Family Sauroidei, Agassiz.

Genus *Pygopterus*, Agassiz.

Esox, *Krüger*.
Palæothryssum, *Blainville*.
Nemopteryx, *Agassiz*.
Sauropsis ,,

Pygopterus mandibularis, *Agassiz*. Plate XXIII, fig. 1 *a*, *b*.

Fossil fish not determined, *Sedgwick*.			Trans. Geol. Soc. Lond., 2d series, vol. iii, p. 118, pl. x, figs. 1-3, 1829.
Nemopteryx mandibularis, s. Sauropsis Scoticus, *Agassiz*.			Arc. Cat.
Pygopterus	—	*Agassiz*.	Poiss. Foss., vol. ii, part ii, pp. 76-77, pl. liii, liii *a*.
(?) —	sculptus	,,	Poiss. Foss., vol. ii, p. 77.
—	Scoticus	,,	Bronn, Lethæa Geognostica, pl. ii, p. 128, 1835.
—	mandibularis	,,	Ann. Mag. Nat. Hist., vol. vii, p. 497, 1841.
—	—	,,	Morris, Catalogue, p. 204, 1843.
—	—	,,	Rep. 13th Meet. Brit. Assoc., p. 198, 1844.
(?) —	sculptus	,,	Loc. cit.

[1] King, Catalogue, p. 15.

PYGOPTERUS MANDIBULARIS, *Agassiz*. De Verneuil, Bull. Soc. Géol. de France, 2me série, vol. i, p. 41, 1844.
— — „ Geol. Russ., vol. i, p. 227, 1845.
— — „ Tennant, Strat. List, p. 89, 1847.
— — „ King, Catalogue, p. 15, 1848.
— — „ Howse, Trans. T. N. F. C., vol. i, p. 236, 1848.

The specimen of *Pygopterus mandibularis* represented in Pl. XXIII, fortunately supplies all parts of the fish deficient in those examined by Professor Agassiz, viz. the pectoral and ventral fins, the anterior portion of the body, and the scapular arch. The ventral fins are situated about midway between the pectoral and anal fins: they are remarkably small as compared with those organs in the genus *Acrolepis*. The pectoral fins are of large size, and composed of a considerable number of rays, divided and subdivided into fine fimbriations at their distal extremities: they are more pointed and not so large as the pectoral fins of *Pygopterus Humboldtii*. The bones composing the scapular arch are thick and strong, in harmony with the entire organization of this fish, adapted as it is for swift progression and predatory power of no ordinary degree. The scales on the anterior part of the fish are neatly and distinctly sculptured somewhat after the pattern of the scales of Acrolepis; but this ornamentation does not extend beyond the insertions of the ventral fins. It is most probable, that the *Pygopterus sculptus*, alluded to by Agassiz at page 77, may have been suggested by a specimen of the anterior portion of the species under description.—P. G. E.

Pygopterus mandibularis occurs in Marl-slate at Whitley, Cullercoats, East Thickley, Ferry-Hill, and Thrislington Gap. The specimen figured, and belonging to the Museum of the Yorkshire Philosophical Society, is from the last locality.

PYGOPTERUS LATUS, *Egerton*. Plate XXIV, fig. 1 *a*.

This very distinct species of *Pygopterus* differs from the other members of the genus in the greater depth of the body, as compared with its length. The only specimen I have seen is in my own cabinet. The bones of the head are dislocated, and the lower extremity is wanting from the point where the vertebral column bends upwards to form the heterocercal tail; but the trunk is perfect, with the exception of the external rays of the fins. It measures twelve inches and a half in length from the insertion of the pectoral fin to the commencement of the lower lobe of the tail, and is five inches in depth at the shoulders, decreasing to four inches and a half at the dorsal fin. A very perfect specimen of *Pygopterus mandibularis* (the one above noticed, with which I have compared it), twelve inches in length, is only three inches and a half deep at the shoulder, and a trifle less at the

dorsal fin. This remarkable discrepancy in form and proportion is associated with other peculiarities in the outline, number, and character of the scales. As in other species of the genus, these are small and uniform, but they are more numerous, there being not less than sixty in each dorso-ventral series in the broad part of the body. The arrangement of each series is less oblique; and the scales are less elongated, especially near the tail, than in *Pygopterus mandibularis*. The scales are ornamented with four or five distinct ridges, somewhat in the manner of those of *Acrolepis*. These are not so numerous, nor so prominent in the caudal region. The bones supporting the dorsal fin rays are strong and much compressed: those of the anal fin are larger and more numerous, but not flattened. It is a very distinct and well characterised species.—P. G. E.

Sir Philip Egerton's specimen of this species was found in the Marl-Slate of Ferry-Hill.

Genus *Acrolepis*, Agassiz.

ACROLEPIS SEDGWICKII, *Agassiz*. Plate XXV, fig. 1 *a*, *b*, *c*.

FRAGMENT OF A FOSSIL FISH; SPECIES NOT ASCERTAINED, *Sedgwick*. Trans. Geol. Soc. Lond., 2d series, vol. iii, p. 117, pl. viii, figs. 3, 4, 1829.

ACROLEPIS SEDGWICKII, *Agassiz*. Poiss. Foss., vol. ii, part ii, pp. 80, 81, pl. lii.

— — ,, Bronn, Lethæa Geognostica, vol. ii, p. 128, pl. x, fig. 6, 1835.

— — ,, Ann. Mag. Nat. Hist., vol. vii, p. 488, 1841.

— — ,, Morris, Catalogue, p. 187, 1843.

— — ,, Rep. 13th Meet. Brit. Assoc., p. 198, 1844.

— — ,, De Verneuil, Bull. Soc. Géol. de France, 2^{me} série, vol. i, p. 40, 1844.

— — ,, Geol. Russ., vol. i, p. 227, 1845.

— — ,, Tennant, Strat. List, p. 89, 1847.

— — ,, King, Catalogue, p. 15, 1848.

— — ,, Howse, Trans. T. N. F. C., vol. i, p. 236, 1848.

The specimen selected to give the best idea of this interesting species is from my own collection. Although it is rather more perfect than Mr. Witham's specimen figured in the 'Poissons Fossiles;' yet it is deficient in those parts still wanting to complete the description of the species, viz. the head, and scapular arch and appendages. The account given by Agassiz is so full and accurate, that it is unnecessary to repeat it here, especially as the subject of the plate was examined by Agassiz before his detailed description was printed. Since the publication of the 'Poissons Fossiles,' a species of this genus has been discovered in the Coal-shale of Berschweiler near Kirn, on the Nahe, so that every genus of Permian fish is now known to be common to that system and the Coal-measures.—P. G. E.

Acrolepis Sedgwickii occurs in Marl-slate at East Thickley, Ferry-Hill, Thrislington Gap, and Whitley.

Family CŒLACANTHIDÆ,[1] Agassiz.

Genus *Cœlacanthus*, Agassiz.

CŒLACANTHUS GRANULATUS, *Agassiz*. Plate XXVIII*.

(?) FOSSIL FISH,[2]	*Sedgwick*.	Trans. Geol. Soc. Lond., 2d series, vol. iii, p. 118, pl. xi, 1829.	
CŒLACANTHUS	GRANULATUS,	*Agassiz*.	Poiss. Foss., vol. ii, part ii, pp. 172, 173, pl. lxii.
—	—	,,	Ann. Mag. Nat. Hist., vol. vii, p. 490, 1841.
—	—	,,	Morris, Catalogue, p. 190, 1843.
—	—	,,	Rep. 13th Meet. Brit. Assoc., p. 198, 1844.
—	GRANULOSUS	,,	De Verneuil, Bull. Soc. Géol. de France, 2me série, vol. i, p. 41, 1844.
—	—	,,	Geol. Russ., vol. i, p. 227, 1845.
—	—	,,	Tennant, Strat. List, p. 19, 1847.
—	—	,,	King, Catalogue, p. 15, 1848.
—	GRANULATUS	,,	Howse, Trans. T. N. F. C., vol. i, p. 237, 1848.

It is very much to be regretted that all efforts to discover the original of pl. xi, vol. iii, 2d series, of the 'Transactions of the Geological Society of London,' have proved ineffectual, since there is much reason to believe it belongs to the genus under notice, and perhaps to the same species. Although the lithograph is rather indistinct, there is yet enough expressed to show the arrangement of the rays of the caudal fin, peculiar to *Cœlacanthus*. A faint concentric pattern is also traceable on various parts of the body, which is characteristic of the scales in this genus. The specimen represented in Pl. XXVIII* is in my own possession. It shows little more of the fish than the figures given by Agassiz; but the scales are in a better state of preservation: they are irregularly rounded, and marked by fine, undulating, concentric lines. The enamel is thickly covered with the granulations which suggested the specific name. The second dorsal fin is also shown: it seems to have been larger, and the rays thicker than in the anal fin opposed to it. The extremity of the tail is dislocated, and is seen in the lower part of the plate.—P. G. E.

Cœlacanthus granulatus is stated to have been found at Ferry-Hill and East Thickley, in Marl-slate. The "Fossil Fish" represented in the 'Transactions of the Geological Society,' 2d series, vol. iii, pl. xi, appears to have been found either at Midderidge, or East Thickley.

[1] The reader is referred to the chapter on the family of the *Asterolepis*, in Hugh Miller's interesting 'Foot-prints of the Creator,' pp. 24-37, for the latest researches on this group; and to Agassiz's 'Monograph of the Fishes of the Old Red Sandstone.'

[2] Professor Sedgwick, comparing this fish with the other species noticed by him, states, that it "differs entirely from all the former, but it is far too imperfect to be referred to any known species or genus." I have in vain endeavoured to obtain a sight of the specimen; but it is now not known where it can be seen.

Cœlacanthus caudalis, *Egerton.* Plate XXVIII, fig. 2.

There is a charming little specimen, in the possession of Lord Enniskillen, of a Cœlacanth, which I am inclined to think can scarcely be referred to the preceding species. Its entire length does not equal that of the tail of the smallest specimen of *Cœlacanthus granulatus* I have seen. The latter species is supposed by Agassiz to have been two feet in length: this fish measures only five inches. The head is rather more than a fifth of the total length; the second fifth includes the first dorsal, the third fifth extends to the back of the second dorsal, and from thence to the end of the tail occupies the two remaining fifths. This large proportion of the caudal region inclines me to adopt the specific name given above. The body is slender, and of uniform size. The first dorsal fin is composed of about eight strong rays: these are carried upon thick interapophyses; and the corresponding neurapophysial elements of the vertebræ are enlarged to support them. The same arrangement is seen in the second dorsal; but the fin-rays are more slender and more numerous. The pectoral, ventral, and anal fins are of moderate dimensions and slender structure. The tail is broader, and terminates more abruptly than that organ in *Cœlacanthus granulatus.*—P. G. E.

Lord Enniskillen's specimen was found in the Marl-Slate of Ferry-Hill.

Class Reptilia, Cuvier.[1]

Professor Owen divides the present group into the following orders,—*Batrachia, Ophidia, Chelonia, Pterosauria, Lacertilia, Dinosauria, Crocodilia,* and *Enaliosauria*, of which the fifth is the only one as yet known to have been represented during the Permian epoch.

Order Lacertilia.

Professor Owen observes, that "among the inferior or squamate Saurians there are two leading modifications in the mode of attachment of the teeth, the base of which may be either anchylosed to the summit of an alveolar ridge, or to the bottom of an alveolar groove, and supported by its lateral wall. These modifications are indicated respectively by the terms 'acrodont' and 'pleurodont.' A third mode of fixation is presented by some extinct Saurians, which, in other parts of their organization, adhere

[1] Not being acquainted with the Permian reptiles,—and as the scope of the present work requires some notice to be taken of them,—I have freely availed myself of the materials which Dr. Riley, Mr. Stutchbury, and Professor Owen have already published thereon.

to the squamate or Lacertine division of the order, the teeth being implanted in sockets, either loosely or confluent with the bony walls of the cavity; these I have termed the 'Thecodont' Lacertians."[1]

The following genera—*Thecodontosaurus* and *Palæosaurus*, which have been established on some teeth and jaws (found along with several other bones in the Magnesian conglomerate near Bristol), belong to this group.

The vertebræ, associated with the teeth and jaws of these Thecodont Lacertians, "are biconcave, with the middle of the body more constricted, and terminal articular cavities rather deeper than in *Teleosaurus;* but they are chiefly remarkable for the depth of the spinal canal at the middle of each vertebræ, where it sinks into the substance of the centrum; thus the canal is wider, vertically, at the middle than at the two ends of the vertebra: an analogous structure, but less marked, obtains in the dorsal vertebræ of the *Rhynchosaurus* from the new Red Sandstone of Shropshire."

"Besides deviating from existing lizards in the thecodont dentition and biconcave vertebræ, the ancient Saurians of the Magnesian conglomerate also differed in having some of their ribs articulated by a head and tubercle to two surfaces of the vertebra, as at the anterior part of the chest in Crocodiles and Dinosaurs. The shaft of the rib was traversed, as in the Ichthyosaur and Rhynchosaur, by a deep longitudinal groove. Some fragmentary bones indicate obscurely that the pectoral arch deviated from the Crocodilian and approached the Lacertian or Enaliosaurian type in the presence of a clavicle, and in the breadth and complicated form of the coracoid. The humerus appears to have been little more than half the length of the femur, and to have been, like that of the *Rhynchosaurus*, unusually expanded at the two extremities.

"The tibia, fibula, and metatarsal bones manifest, like the femur, the fitness of the thecodont Saurians for progression on land. The ungual phalanges are sub-compressed; curved downwards, pointed, and impressed on each side with the usual curved canal."

The general conclusions which may be drawn from the knowledge at present possessed of the osteology of *Thecodontosaurus* and *Palæosaurus* "are, that in their thecodont type of dentition, biconcave vertebræ, double-jointed ribs, and proportionate size of the bones of the extremities, they are nearly allied to the *Teleosaurus;* but that they combine a Lacertian form of tooth, and structure of the pectoral and probably pelvic arch with these Crocodilian characters, having distinctive modifications, as the moniliform spinal canal, in which, however, the almost contemporary Rhynchosaur participates." (Owen.[2])

[1] 'Report on British Fossil Reptiles,' in Report of the Eleventh Meeting of the Brit. Assoc., p. 153, 1842.

[2] Ibid., pp. 153-155.

Genus *Thecodontosaurus*, Riley and Stutchbury.

"The genus *Thecodontosaurus* is founded on the structure of the teeth, and their having been deposited in distinct alveoli."[1] In these characters it is allied to the typical Varanian Monitors; but with this difference, that the teeth are "imbedded in distinct sockets; to this condition, however, the *Varani*, among the squamate Saurians, make an approach in the shallow cavities containing the base of the teeth along the bottom of the alveolar groove.

"In the ancient extinct genus in question the sockets are deeper, and the inner alveolar wall is nearly as high as the outer one; the teeth are arranged in a close-set series, slightly decreasing in size towards the posterior part of the jaw; each ramus of the lower jaw is supposed to have contained twenty-one teeth. These are conical, rather slender, compressed and acutely pointed, with an anterior and posterior finely-serrated edge, the serratures being directed towards the apex of the tooth, as in the genus *Rhopalodon* of G. Fischer; the outer surface is more convex than in the inner one; the apex is slightly recurved; the base of the crown contracts a little to form the fang, which is sub-cylindrical. The pulp-cavity remains open in the base of the crown. In their microscopic structure, the teeth of *Thecodontosaurus* closely correspond with that of the teeth of the *Varanus*, *Monitor*, and *Megalosaurus*. The body of the tooth consists of compact dentine, in which the calcigerous tubes diverge from an open pulp-cavity at nearly right angles to the surface of the tooth; they form a slight curve at their origin, with the concavity directed towards the base of the tooth; then proceed straight, and at the periphery bend upwards in the contrary direction. The diameter of the calcigerous tube is $\frac{1}{30,000}$th of an inch; the breadth of the interspace of the tubes is $\frac{1}{8000}$ of an inch. The crown of the tooth is invested with a simple coat of enamel."

"The microscopic examination of the structure of the teeth, which I have been enabled to make by the kindness of Mr. Stutchbury, satisfactorily establishes the distinction between the Saurian of the Bristol conglomerate, and the reptiles of the later member of the new red sandstone system in Warwickshire, which I have described under the name of *Labyrinthodon*." (Owen, Op. cit.)

THECODONTOSAURUS ANTIQUUS, *Riley and Stutchbury.*

SAURIAN, *Williams.* Proceedings of the Geol. Soc. Lond., vol. ii, p. 112, 1834.
THECODONTOSAURUS, *Riley and Stutchbury.* Proceedings of the Geol. Soc. Lond., vol. ii, p. 398, 1836.

[1] Riley and Stutchbury Proceedings of the Geol. Soc., vol. ii, p. 398.

An Additional Species, *Riley and Stutchbury.*			Sixth Report of the British Association, Trans. Sect., pp. 90-93, 1837.
Thecodontosaurus		„	Trans. Geol. Soc., 2d series, vol. v, p. 350, pl. xxix, figs. 1, 2, 3, 1837.
—		„	Phillips, Lardner's Cyclop., Geology, vol. i, p. 190, 1837.
—	antiquus.		Owen, Eleventh Report Brit. Assoc., p. 190, 1842.
—	—	„	Morris, Catalogue, p. 211, 1843.
—	—	„	De Verneuil, Bull. Soc. Géol. de France, 2me série, vol. i, p. 42, 1844.
—	—	„	Geol. Russ., vol. i, p. 228, 1845.
	—	„	Tennant, Strat. List, p. 88, 1847.

The Rev. David Williams, Dr. Riley, and Mr. Stutchbury have described some jaws and teeth of this species. One of these remains, which is in the "Museum of the British Institution, is the right ramus of a lower jaw, three and a quarter inches long, and one and a half in the greatest depth, from the summits of the teeth to the under rise, consisting of the dental bone, containing twenty-one teeth, with portions of the sub-angular and complementary bones, and perhaps traces of the opercula. The alveolar groove for the reception of the teeth is formed by two ridges of nearly equal height, the teeth being deposited in it, in distinct alveoli, to nearly half their length. The teeth somewhat resemble a surgeon's abscess-lancet, being acutely pointed, and flattened; while the anterior edge is also curved, but concave and strongly serrated, the serrature being directed towards the apex of the tooth. The middle teeth are the largest, rising not less than a quarter of an inch above the socket."[1]

Thecodontosaurus antiquus was discovered in conglomerate resting on the edge of inclined strata of mountain limestone at Redland near Bristol.

Genus *Palæosaurus*, Riley and Stutchbury.

"The characters of this group are derived from certain teeth, which are described as being carinated laterally, and finely serrated at right angles to the axis."[2]

Palæosaurus platyodon, *Riley and Stutchbury.*

Saurian, *Williams.*			Proc. Geol. Soc., vol. ii, p. 112, 1834.
Palæosaurus platyodon, *Riley and Stutch.*			Proc. Geol. Soc., vol. ii, p. 398, 1836.
—	—	„	Sixth Report Brit. Assoc., Trans. Sec., p. 91, 1837.
—	—	„	Trans. Geol. Soc., 2d series, vol. v, p. 352, pl. xxix, fig. 5, 1837.

[1] Riley and Stutchbury, Proceedings of the Geol. Soc., vol. ii, p. 398.

[2] Ibid.

Palæosaurus platyodon, *Riley and Stutch.*			Owen, Eleventh Report Brit. Assoc., p. 154, 1842.
—	—	,,	Morris, Catalogue, p. 209, 1843.
—	—	,,	De Verneuil, Bull. Soc. Géol. de France, 2me série, vol. i, p. 42, 1844.
—	—	,,	Geol. Russ., vol. i, p. 226, 1845.
—	—	,,	Tennant, Strat. List, p. 89, 1847.

"In the formation which contained the jaw and teeth of the *Thecodontosaurus*, two other teeth were separately discovered, differing from the preceding and from each other; the crown of one of these teeth measuring nine lines in length and five lines in breadth. It is compressed, pointed, with opposite trenchant and serrated margins; but its breadth, as compared with its length, is so much greater than in the *Thecodontosaurus*, that Dr. Riley and Mr. Stutchbury have founded upon it the genus *Palæosaurus*, and distinguished it by the specific name of *platydon*." (Owen, Op. cit.)

Palæosaurus cylindrodon, *Riley and Stutchbury.*

Saurian, *Williams.*			Proc. Geol. Soc., vol. ii, p. 112, 1834.
Palæosaurus cylindrodon, *Riley and Stutch.*			Proc. Geol. Soc., vol. ii, p. 398, 1836.
—	—	,,	Sixth Report Brit. Assoc., Trans. Sec., p. 92, 1837.
	—	,,	Trans. Geol. Soc., 2d series, vol. v, p. 352, pl. xxix, fig. 4, 1837.
—			Phillips, Lardner's Cyc., Geology, vol. i, p. 190, 1837.
—	—	,,	Owen, Eleventh Report Brit. Assoc., p. 154, 1842.
	—	,,	Morris, Catalogue, p. 209, 1843.
—	—	,,	De Verneuil, Bull. Soc. Géol. de France, 2me série, vol. i, p. 42, 1844.
—	—	,,	Geol. Russ., vol. i, p. 228, 1845.
—	—	,,	Tennant, Strat. List, p. 89, 1847.

The species has been founded on the second tooth noticed under *Palæosaurus platyodon*.

"The portion of the tooth of the *Palæosaurus cylindrodon* which has been preserved, shows that the crown is sub-compressed and traversed by two opposite finely-serrated ridges, as in the *Thecodontosaurus* and *Rhopalodon;* its length is five lines, its breadth at the base two lines." (Owen.[1])

The Reptilian remains herein described "were found in quarrying the brecciated

[1] Eleventh Rep. Brit. Assoc., p. 154.

beds, which rest upon the highly inclined carboniferous limestone at Redland, the south-eastern extremity of Durdham Downs, near Bristol. The breccia at this spot is not more than twenty feet thick, and is composed of angular or slightly worn fragments of mountain limestone, cemented by a red or yellow magnesian paste." (Riley and Stutchbury.[1])

"The blocks of stone in which these remains are met with, are sometimes so filled with bones, that they would be called osseous breccia by those not aware of their origin."[2]

[1] Trans. Geol. Soc. Lond., 2d series, vol. v, p. 349.

[2] Riley and Stutchbury, Sixth Rep. Brit. Assoc., Trans. Sect. p. 92.

APPENDIX.

Sigillaria and *Stigmaria*, p. 9.

Since my remarks on these fossils were written, my attention has been drawn to a paper by Mr. Richard Brown, entitled 'Description of erect *Sigillariæ* with conical Tap-roots, found in the Roof of the Sydney Main Coal, in the Island of Cape Breton,' (Quarterly Journal of the Geological Society, vol. v, part i, pp. 354-360,) which completely sets at rest the question as to *Stigmaria* being the root of *Sigillaria*. The evidence adduced by Mr. Brown is quite conclusive; inasmuch as he describes a stem, evidently a Sigillaria, still attached to its root, which is clearly a Stigmaria. It does not appear that Mr. Brown has read my 'Contributions towards establishing the general Characters of the Fossil Plants of the genus *Sigillaria*,' or he would have seen, that it contained a complete demonstration of the 'Dome-shaped Fossil' described in the 'Fossil Flora,' being no other than a root. The fossil roots, which Mr. Brown notices in his paper, have the underside of their base "divided into four equal quarters by deep channels running from near the centre, &c." (p. 357.) In my 'Contributions,' specimens of *Stigmaria* are noticed, displaying two furrows, or ridges (depending on whether the specimens were the fossils themselves, or merely their impressions) crossing each other, dividing them into four nearly equal quarters. As regards the cause of these furrows, or impressions, Mr. Brown's observations have completely explained it; and I now perceive, that my opinion on this point is altogether incorrect.

Allusion is made in my paper to the quincuncial arrangement of the fibrils of *Stigmaria* opposing the view of its being a root: M. Brongniart, however, in noticing the same objection, states, that a similar arrangement prevails "rather often in the roots of aquatic plants," but without naming the species. By repeatedly endeavouring to find out plants having their fibrils thus characterised, I have at least ascertained, that the roots of the common *Iris Pseudo-Acorus*, when deprived of their fibrils, show the scars to be as distinctly arranged in quincunx as those of *Stigmaria ficoides*.

Actinaria, p. 21.

Several years since, I found in Whitley Quarry a branched Coral, about three inches long, resembling a *Lithodendron*. The specimen has been lost; and I have never been able to find another of the same kind.

Fenestellidæ, pp. 37, 40.

I have lately ascertained, that Professor Oldham has anticipated me in the discovery of the root-like processes which are attached to the ribs or stems of this family. (*Vide* Journal of the Geological Society of Dublin, vol. III, part iii, pp. 190-193, plate 3.)

Thamniscus dubius, p. 44.

This fossil and the following were found in a fragment of magnesian limestone, brought up, by a fisherman's line, from the bottom of the Coral-zone trough, between the Dogger-bank and the coast of Northumberland, about 30 miles from the latter. The circumstance is noticed here, as it may assist, with other facts, in throwing some light on the geology of this submarine region.

1. *Thamniscus dubius.*
2. *Archæocidaris Verneuiliana.*
3. *Cyathocrinus ramosus.*
4. *Cythere elongata.*
5. *Trigonotreta multiplicata.*
6. *Epithyris elongata.*
7. *Pecten pusillus.*
8. *Monotis speluncaria.*
9. *Bakevellia ceratophaga.*
10. *Turbo helicinus.*

Palliobranchiata (Histology of), pp. 91, 110, 117, 124.

The reader is referred to some observations by Vicomte d'Archiac, on the nature of the shell-tissue of this class of Mollusks, in the 'Mém. Soc. Geol. de France,' 2me s., tome ii, part ii; as I am anxious that he be in possession of all that has been published on this still-imperfectly understood subject.

Palliobranchiata (Classification of), p. 81, &c.

Some facts, which have lately come to my knowledge, induce me to make a few slight modifications in some of the Ancylobrachial families and genera.

Leaving untouched the two families *Thecidæidæ* and *Argiopidæ*, I am led to think, that the genera included in the families *Terebratulidæ* and *Rhynchoridæ*, ought to be arranged according to the character of their apophysary system. I am not quite acquainted with the principles of M. d'Orbigny's classification; it is, therefore, possible, that he may have anticipated me in some of the following views. Guided by the beautiful figures which Mr. T. Davidson has from time to time published of the interiors of certain Ancylobrachial genera,—particularly in a late number (June) of the 'Annals and Magazine of Natural History,'—there is every reason for believing, that two principal forms of the apophysary system generally prevail;—one in which *the loop* is simply attached by its posterior parts to the crural processes; and another, in which it is attached both posteriorly to the crura, and anteriorly to the medio-longitudinal plate. *Waldheimia Australis* affords a good illustration of the first form; and *Terebratella Chilensis* of the second. By considering these forms of the loop, as of fundamental importance in classification, we certainly bring together, in the same group, genera, which, in their external characters, differ widely from each other;—as *Megerlia* and *Terebratella*,—the former with an area, and the latter without one; *Waldheimia* and *Delthyridæa* (? *D. pulchella Tereb. id.*[1] Nilson), which stand in precisely the same relation to each other. But I am strongly

[1] I regret not having been able to obtain any information respecting the apophysary system of *Terebratula pectiniformis*, which appears to be the type of M'Coy's genus *Delthyridæa*. Is there any generic relation between this species and Nilson's *Terebratula pulchella?* Mr. Davidson has published a beautiful figure of the interior of the latter shell. Externally, both have a striking resemblance to each other; and it is further established, by *Terebratula pulchella* having, as Mr. Davidson informs me, the apex of the umbone truncated with a foramen. The next point for inquiry is,—does the loop of *Terebratula pectiniformis* agree with that of *Terebratula pulchella* in having a single attachment; if so, the latter will have to be placed in the genus *Delthyridæa*, and stationed in the family *Terebratulidæ*.

disposed to consider, that similarity of apophysary systems constitutes a stronger bond of generic affinity than similarity of external characters; and in this respect, I believe, that I am fortified by the opinion of Mr. Davidson, whose knowledge of the interiors of Ancylobrachial genera is of the highest order.

Now, as the first-described genus of the singly-attached-looped Ancylobrachial group is *Terebratula*, it will be necessary, in considering this group as a family, to name it *Terebratulidæ;* and, on the other hand, as the original genus of the doubly-attached-looped Ancylobrachials is *Terebratella*, we are also compelled to consider these, as constituting the family *Terebratellidæ*. These two families may, therefore, be constituted as follows:

Terebratulidæ.	*Terebratellidæ.*
(Genera with a singly-attached loop.)	(Genera with a doubly-attached loop.)
Terebratula.	*Terebratella.*
Terebratulina.	*Megerlia.*
Delthyridæa (?)	*Ismenia.*
Waldheimia.	
Epithyris.	
Pygope.	

It requires to be observed, that I now entertain very little opinion of any of the above genera being *without an apophysary system:* if this be correct, *Rhynchora* will have to be stationed in either one or the other of the above families. The family *Rhynchoridæ*, if its type have a doubly-attached loop, will have to bear this name instead of that of "*Terebratellidæ;*" but until this is settled, it seems preferable to make use of the latter name.

Strophalosia Morrisiana, p. 99.

An oversight was made when describing this species. Nothing was then stated of the lower or small valve being furnished with spines. Figure 26, in Plate xii, represents a gutta percha cast of an impression of this valve, found in Whitley Quarry, which shows that the spines are not so numerous as those of *Strophalosia excavata*, nor so regularly arranged.

Spiriferidæ (Apophysary system of), p. 122.

In noticing the *cross-piece* which Mr. Davidson has discovered connecting the two spirals of some of the Jurassic forms of this family, I made the suggestion, that it had resulted from the approximation or union of the two crural processes. This view is strongly supported by what is seen in the loop of *Terebratulina caput-serpentis*, as will be shown hereafter.

Ismenia, pp. 142-145.

Through an error, I typified this genus with Schlotheim's *Terebratulites pectunculus*, instead of his *Terebratulites pectunculoides*. I am enabled, by the beautiful figure which Mr. Davidson has lately published of the latter species (*Vide* Annals and Mag. of Nat. Hist., 2d series, vol. v, plate xv, fig. 5), to add to the diagnosis of this genus the following character of its apophysary system: *Loop* elongated; deeply recurved; armed at the recurving bend with several cilia-like processes; and attached anteriorly to a long medio-longitudinal plate.

Magasidæ, p. 142.

Mr. Davidson has lately described a new genus under the name of *Waltonia*, and placed it, correctly I think, in the present family. I formerly had some doubts as to the distinctiveness of *Magasidæ;* but I now think, that it is essentially different from both *Terebratulidæ* and *Terebratellidæ*, in its apophysary system being without the recurved portion: in having a doubly-attached loop, it appears to be more related to the last-named family than to the first one.

Terebratula, p. 143.

Mr. J. G. Jeffreys having kindly favoured me with some instructive specimens of *Terebratulina caput-serpentis*, with the loop and labial appendages preserved, and Mr. Davidson having sent me a sketch of the apophysis of *Terebratula vitrea*, I am now better enabled to appreciate the reasons which led M. d'Orbigny to place these shells in distinct genera. The loop, both in *Terebratula*, and *Terebratulina*, is remarkably short; therefore, in the former, it appears to serve the same purpose as it does in the latter, that is, in principally affording support to the visceral parts, rather than the labial appendages, as in *Waldheimia:* but the form of the loop is singularly modified,—being not much recurved, and open posteriorly, in *Terebratula vitrea*,—and very slightly recurved, and anneliform, in *Terebratulina caput-serpentis*. This difference, however, is easily explained on the idea, that the annular shape of the loop (or rather the presence of its posterior cross-piece, to which the form of the loop is due) of the last-named shell, has resulted from the complete union of the free or projecting portions of the two crural processes.

Eudesia, p. 144.

Mr. T. Davidson has just forwarded to me a sketch of the loop of Lamarck's *Terebratula Cardium* (*T. orbicularis*, J. Sow.), which I proposed as the type of this genus. It so closely agrees with the loop characteristic of *Waldheimia*, that I am disposed to cancel *Eudesia*.

Lamellibranchiata (Perforating), p. 152.

Perforating bivalves appear to have existed during the Permian epoch; as I have a specimen of compact limestone from Midderidge, with perforations closely resembling those made by *Pholas parva*, and *P. crispata* in limestone. Near Cong, Galway, there are several deep tubular holes in limestone, strikingly resembling those made by the above terebrating shells, displaying no other apparent cause of their formation, than the action of some principle in the *nearly still water* which they contain. They seem to point out, that a weak chemical solvent, aided by very slight mechanical action on the part of the animal, powerfully contributes in enabling perforating shells to make excavations in limestone rocks.

Solemyidæ, p. 177.

In the page above referred to, I made the carboniferous *Solemya primæva*, Phillips, typical of a new genus —*Janeia*, which I purposed reverting to in the present place, with the view of showing in what respects it differed from Lamarck's genus *Solemya*, the type of which is the *S. Australis* of the same authority. But I now feel convinced, from an examination of an instructive specimen of the latter species, sent me by my friend Mr. Pickering, and of some casts of the former, exhibiting the muscular and cartilage impressions very distinctly, that they cannot be generically separated. I was led to think, that these shells were so far distinct, from the following circumstances, and from an examination of an imperfect specimen of *Solemya*

Mediterranea. In none of the descriptions which I had read of *Solemya* is there any allusion made to its having a double or divided cartilage, or to that division, which is situated within the umbonal cavity; only the large triangular portion, placed on the short side of the shell, is noticed. As my casts of *Solemya primæva* exhibit the impressions of the umbonal division of the cartilage, and not those of the triangular portion (this last circumstance is explained by the peculiar way in which the cartilage is attached to its fulcra), I was induced to infer, that this fossil differed from the recent species noticed, in having the cartilage undivided, and situated within the umbonal cavity. Further: from the prevailing misapplication of the terms *anterior* and *posterior* to the two extremities of *Solemya*, in consequence of its being generally understood that the cartilage, in the recent species, is situated on the posterior end, that is, on the short side,—and from the impressions of this structure, in the fossil species, being underneath the umbones, and consequently on the opposite or long side,—I was also led to infer, that the latter differed from the former, in having the cartilage placed within the umbonal cavity, and not behind it. That those conchologists, however, are in error, whose description of *Solemya* states, or implies, that the cartilage is situated on the posterior side of the valves, will be readily perceived by a reference to the figures of the animal of *Solemya Mediterranea* in Philippi's 'Enumeratio Molluscorum Siciliæ,' and in plate 115 of the Atlas of 'Les Mollusques,' accompanying the 'Reunion' edition of Cuvier's 'Règne Animal,'—which figures show the remarkable and singular peculiarity of one of the divisions of the cartilage placed in front of the umbones, over the oral apparatus, where the lunette is usually situated in other bivalves.

I shall, in the next place, introduce a diagnosis of *Solemya*, which I am desirous should be substituted for the section on *Janeia* in page 177.

Genus *Solemya*, Lamarck.

Diagnosis.—Transversely elongated: equivalved: inequilateral, the posterior side being the longest: obtuse at the extremities. *Epidermis* shining; reaching beyond the margins of the valves. *Umbones* scarcely prominent. *Cartilage* internal; divided; one portion (the largest) situated in front of the umbones on two oblique lamelliform callosities or fulcra, having their free margin slightly separated from the inner surface of the valves,—the separation containing the cartilage; the other and smallest portion slightly spreading over the inner surface of the valves within the umbonal cavities. *Pallial line* entire, and marginal.

Gasteropoda (Carnivorous).

I have elsewhere noticed (Vide London Geological Journal, vol. i, p. 11; and description of plate xv, lines 7 and 8) the drilled holes observable on some of the fossils described in the present Monograph, and which indicate the existence of Carnivorous Gasteropods during the Permian period. The following are the shells in which I have observed these perforations,—*Bysso-arca tumida, Mytilus squamosus, Epithyris sufflata,* and *Trigonotreta multiplicata.*

Calyptræa antiqua, Howse.

A doubtful fossil, with this name, is described as follows in the 'Transactions of the Tyneside Naturalists' Field Club,' vol. i, p. 242.

"Shell small, patelliform; strongly ribbed longitudinally; margin crenulated; two deep furrows internally, from the apex to the margin, corresponding with two strong ribs on the outer surface.

"In Magnesian limestone; rare. Tunstall Hill.

"Only one small specimen of the shell has occurred. The characters noted above are very conspicuous, and its strong resemblance to many Calyptræa has induced us to place it in that genus."

Ammonites, Sedgwick, p. 219.

Professor Sedgwick states, that "a cast of a small Ammonite was found among the Humbleton fossils" (Trans. Geol. Soc. London, 2d series, vol. iii, p. 118). I have often suspected the cast alluded to, to be a specimen of *Nautilus Freieslebeni;* but I am prevented offering a positive opinion on this point, in consequence of Professor Sedgwick having stated in his 'Anniversary Address to the Geological Society,' for 1829, that "the only Ammonite I have ever found in the Magnesian limestone, had those suture-like markings which distinguish this genus in the upper secondary rocks." (Proceedings of the Geological Society, vol. i, p. 284.) Unfortunately, the specimen has been mislaid; but Professor Sedgwick informs me, that he still thinks, it had plates with uneven margins, and might, therefore, belong to the genus *Ceratites*, which is probable enough, considering, that species of this group occur in the more recent rocks of St. Kassian.

CHRONOLOGICAL LIST

OF

WORKS DESCRIBING, OR REFERRING TO PERMIAN FOSSILS.

1710.—Spener. Miscellania Berolenensia. (*Protorosaurus Speneri.*)

1718.—Link. A Letter to Woodward; published in the Acta Eruditorum. Lipsiæ. (*Protorosaurus Speneri.*)

1720.—Mylius. Memorabilia Sax. subter. (*Pygopterus Humboldti*, and Chemnitz Star-stones.)

1734.—Swedenborg. De Regnum Subterraneum, sive Minerale de Cupro et Orichaleo. (*Protorosaurus Speneri*, &c.)

1745.—Hoppe. Kurze Beschreibung versteinerter Gryphiten, &c. (*Productus horridus.*)

1755.—Knorr. Die Naturgeschichte der Versteinerungen, zur Erlauterung der Knorrischen Sammlung der Merkwürdigkeiten der Natur. (Fishes and Algæ). Nurnberg.

1762-1769.—Walch. Das Steinreich systematisch entworfen. (Fishes, Star-stones, and *Productus horridus.*)

1775.—Schröter. A Paper, entitled 'Von dem innern Bau der Gryphiten.' (*Productus horridus.*) In the Journal für die Liebhaber des Steinreichs und der Konchyliologie.

1779.— „ Lithologisches Real und Verballexikon, &c. (*Productus horridus.*)

1780.—Walch. Beytrag zur Geschichte der Gryphiten. (*Productus horridus.*)

1804.—Parkinson. Organic Remains of a Former World, &c., vol. 1. (Chemnitz Star-stones.)

1804.—Schlotheim. Flora der Vorwelt.

1807.–1817.—Freiesleben. Geognostischer Beitrag zur Kenntniss des Kupfer-schiefergebirges. (Plants, Shells, and other Fossils.)

1809.—Schlotheim. 'Brief an dem Geheimen Rath Karsten.' Der Gesellschaft naturforschender Freunde zu Berlin, Magazin für die neuesten Entdeckungen in der gesammten Naturkunde.

1812.–1836.—Cuvier. Recherches sur les ossements Fossiles de Quadrupèdes. (*Protorosaurus Speneri.*—Monitor de Thuringe.)

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— Australis (muscular system of)	74

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PLATE I.[1]

Fig.

1. Chondrus (?) Binneyi, *King*. Natural size. From the Red Marl at Newton, near Manchester. From a specimen in the cabinet of Mr. E. W. Binney.

1 *a* — — Magnified figure showing the polygonal form of the seed-vessels, caused by pressing against each other, as exhibited in the upper part of the specimen.

2. Polysiphonia (?) Sternbergiana, *King*. Natural size. Marl-slate Thickley.

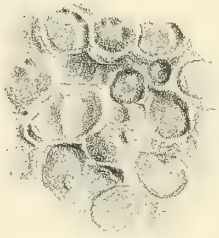
3, 3 *a*. Caulerpa (?) selaginoides, *Sternberg*. Fig. 3 *a* belongs to the lower part of fig. 3. View of a specimen of the natural size presented by Mr. G. Rippon to the Museum of the Natural History Society of Northumberland, Durham, and Newcastle-on-Tyne. Cornforth.

4. Neuropteris Huttoniana, *King*. A pinnule nearly twice the natural size, showing the venation. Marl-slate, Thrislington Gap.

[1] All the fossils figured belong to the author unless otherwise expressed.

1

1a



2

3

4

3a

Jos. Dinkel del et lith.

Day & Son Lith.rs to The Queen

PLATE II.

Fig.

1. Scyphia tuberculata, *King*. Twice the natural size. Humbleton Hill.
2. — — Thrice the natural size. With indistinct indications of excurrent openings on the crown of the tubercles. Dalton-le-Dale.
3. Mammillopora mammillaris, *King*. Twice natural size. Humbleton Hill.
4. — — Highly-magnified view of one of the mammillæ showing the polygonal pores.
5. Tragos Tunstallensis, *King*. A little enlarged. Tunstall Hill.
6. — Binneyi, *King*. Four times less than the natural size. Bedford, near Manchester. Mr. E. W. Binney's specimen.
7. Bothroconis plana, *King*. Portion (natural size) of a large specimen. Tunstall Hill.

7 *a* — — Highly-magnified figure showing hemispherical cavities (*a*), and the supposed excurrent openings (*b*).

8. Fenestella retiformis, *Schlotheim*. Natural size. Humbleton Hill.

8 *a*. — — — Idem. Idem.

9. — — Highly-magnified view of stems or ribs (*a*), showing cellule-apertures (*b*), and the dividing ridge (*c*) slightly tuberculated : *d*, meshes, *e*, transverse processes.
10. — — Figure showing the tubercles (? gemmuliferous vesicles) on the ridges, more developed than in the last.
11. — — Figure showing the same structures open at the summit.
    (Through a mistake the letter *f* points to the cellule-apertures instead of the tubercles on the dividing ridges.)
12. — — Figure showing (?) gemmuliferous vesicles closed.
13. — — Highly-magnified view of a natural *impression* of the celluliferous surface, showing impressions of the stems or ribs (*a*), cellule-apertures (*b*), meshes (*d*), and (?) gemmuliferous vesicles (*f*). (The right-hand letter *d* should be *b*.)
14. — — Natural impression of non-celluliferous surface, showing impressions of the ribs, transverse processes, and meshes.
15. — — Magnified view of casts of cellules (*a*) from their under or basal side.
16. — — Highly-magnified view of non-celluliferous surface of stems or ribs, showing foramina (*a*).
17. — — Figure showing foraminated, vertical, capillary tubes forming the non-celluliferous portion of the ribs.
18. — — Figure of a gutta-percha cast of a natural impression showing root-like processes. Natural size.
19. — — Magnified view, showing the root-like processes striking off from the stem.

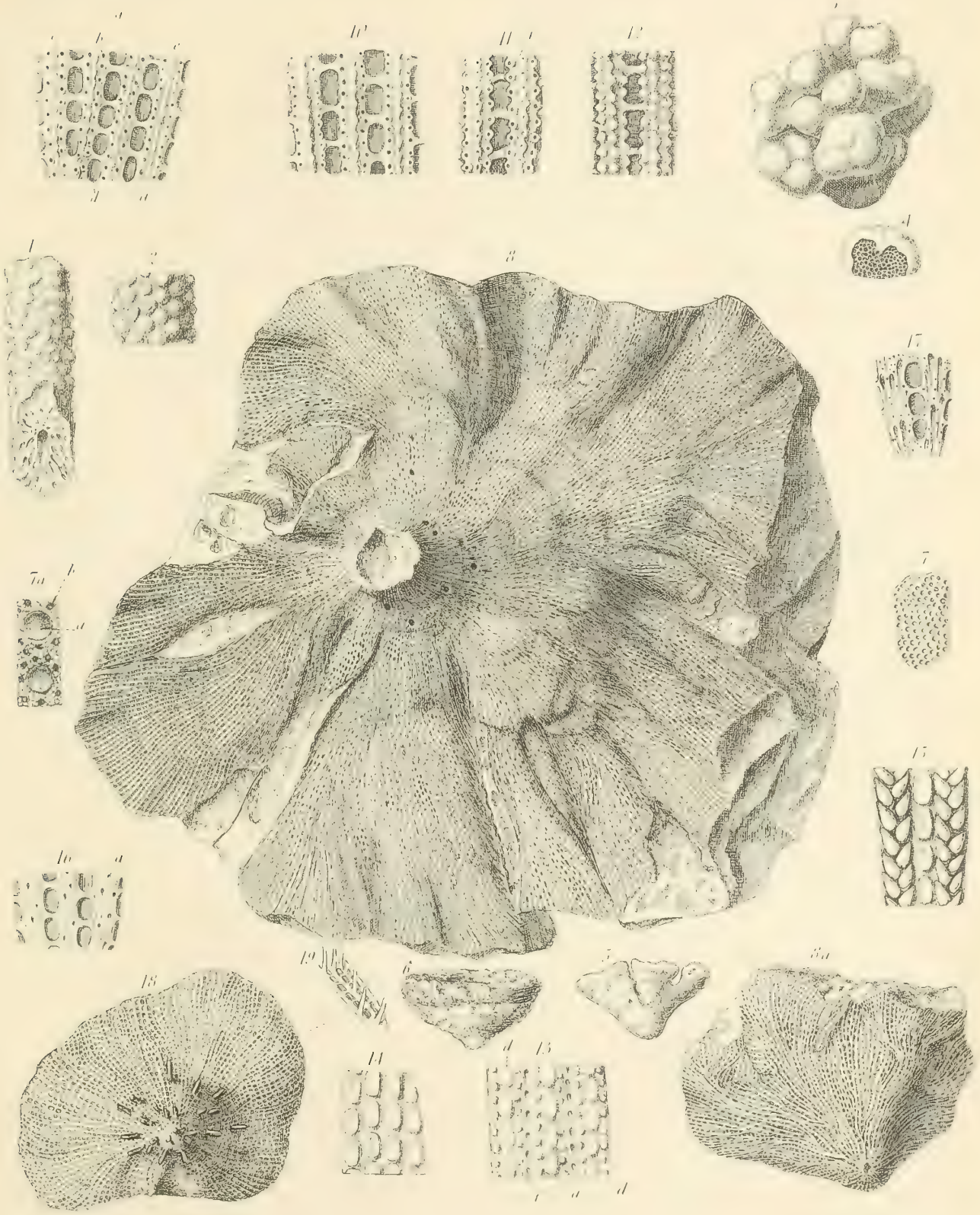


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PLATE III.

Fig.

1. Calophyllum Donatianum, *King*. Twice the natural size. Humbleton Hill.
2. Petraia profunda, *Germar*. Thrice the natural size. The dotted line gives a restored outline of the lower half. Humbleton Hill.
3. Calamopora Mackrothii, *Geinitz*. Thrice the natural size. Tunstall Hill.
4. — — Highly-magnified figure of the tube-apertures, and the denticulated dissepiments.
5. — — Longitudinal section, twice the natural size, showing casts of the tubes. Humbleton Hill.
6. — — Highly-magnified view of a section of the tubes, showing transverse plates (*a*), and mural foramina (*b*). Tunstall Hill.
7. Stenopora columnaris, *Schlotheim*. Figure (thrice the natural size) of a specimen incrusting some encrinal internodes. The tubes are in the state of casts. Tunstall Hill.
8. — — Magnified view of a specimen, showing mature tubes (*a*), and new tubes (*b*) originating from the sides of the former. Humbleton Hill.
9. — — Specimen (natural size) incrusting some encrinal internodes. Humbleton Hill.
10. Alveolites Buchiana, *King*. Nearly twice the natural size. Humbleton Hill.
11. — — Highly-magnified figure showing the tube-apertures (*a*), and tuberculated dissepiments (*b*).
12. — — Diagram showing tubes.
13. Aulopora Voigtiana, *King*. Thrice the natural size. Humbleton Hill.
14. Synocladia virgulacea, *Phillips*. Natural size. Humbleton Hill.

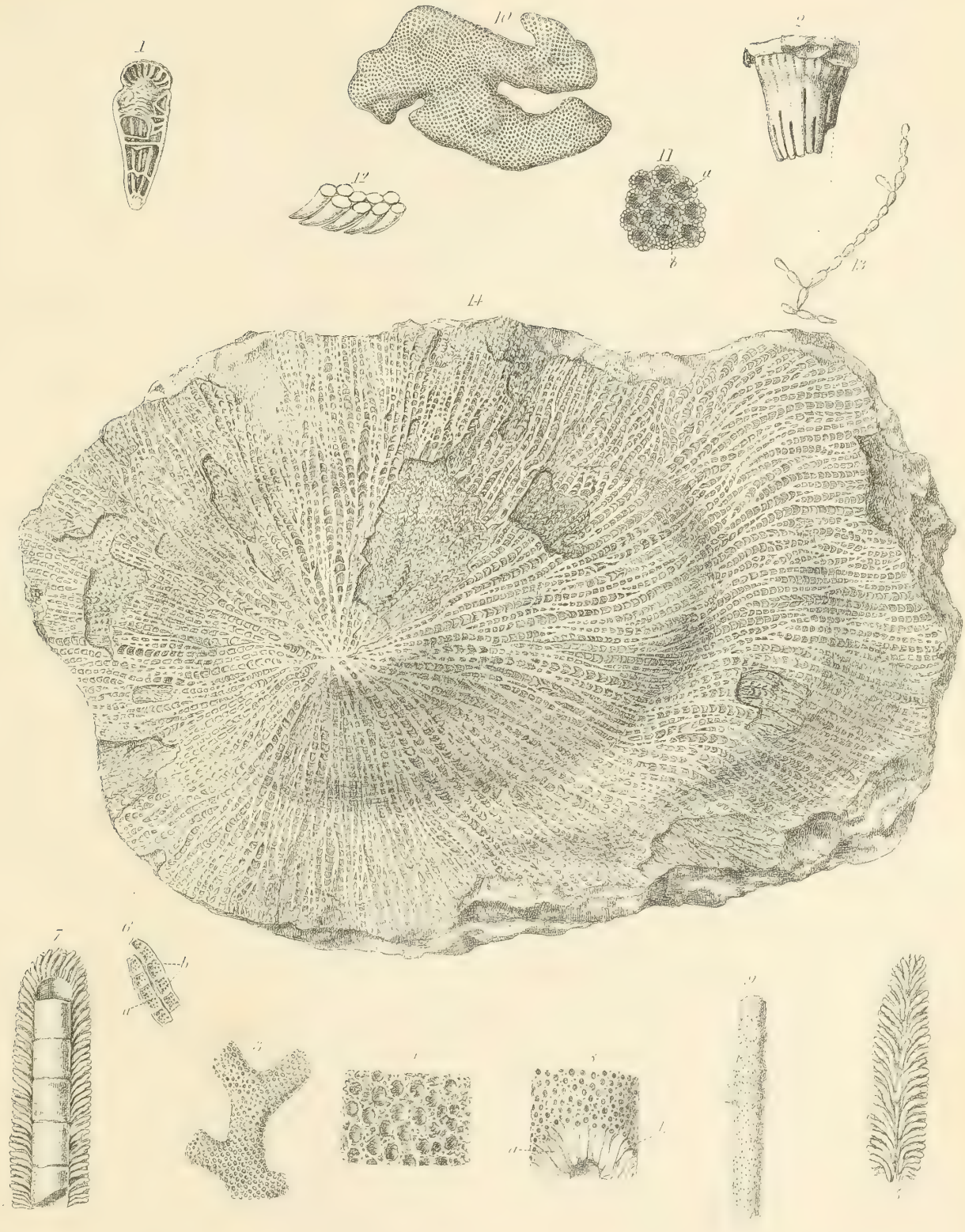

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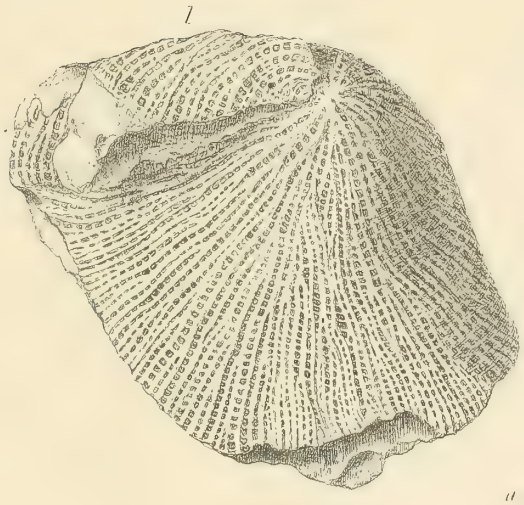
PLATE IV.

Fig.

1. Synocladia virgulacea, *Phillips*. Specimen, natural size, showing non-celluliferous surface of the stems. Humbleton Hill.
2. — — Non-celluliferous surface of another specimen; a little enlarged. Humbleton.
3. — — View of the inner or celluliferous surface of the stems, at the bottom of a cup-shaped specimen; a little enlarged. Humbleton Hill.
4. — — Highly-magnified figure, showing casts of cellules (*a*) looking at their base, with the basal plate removed. *b*, impression of the celluliferous surface of a stem; *c*, impressions of cellule-apertures; *d*, impressions of the (?) gemmuliferous vesicles on the dividing ridges.
   (The letter *d* points to the cellule-apertures instead of the row of pits adjoining them.)
5. — — Highly-magnified view of the celluliferous surface of the stems (*a*), with the (?) gemmuliferous vesicles (*d*) on a dividing ridge; and branches or connecting processes (*b*), with the cellule-apertures (*c*). Tunstall Hill.
6. — — Diagram showing the cellules (*a*) planted on the basal plate (*b*).
7. — — Gutta-percha cast of a natural impression, showing root-like processes striking off from the non-celluliferous surface of the stems.
8. — — Same as last, highly-magnified. *a*, root-like processes.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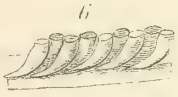
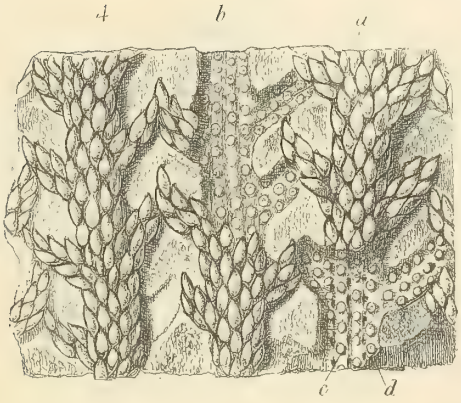
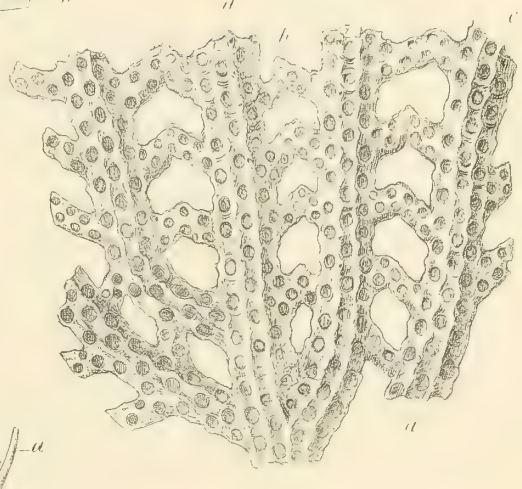
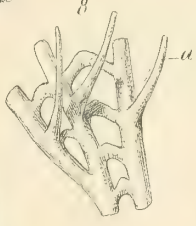
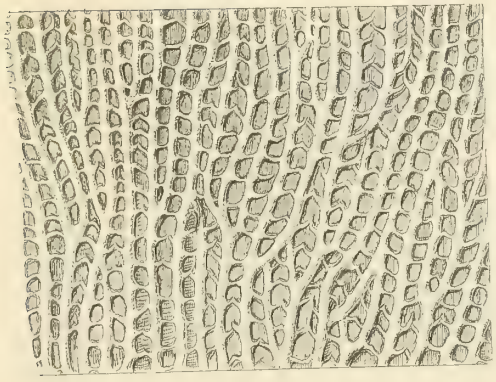

6 a b


4 b a c d


5 d b c a


8 a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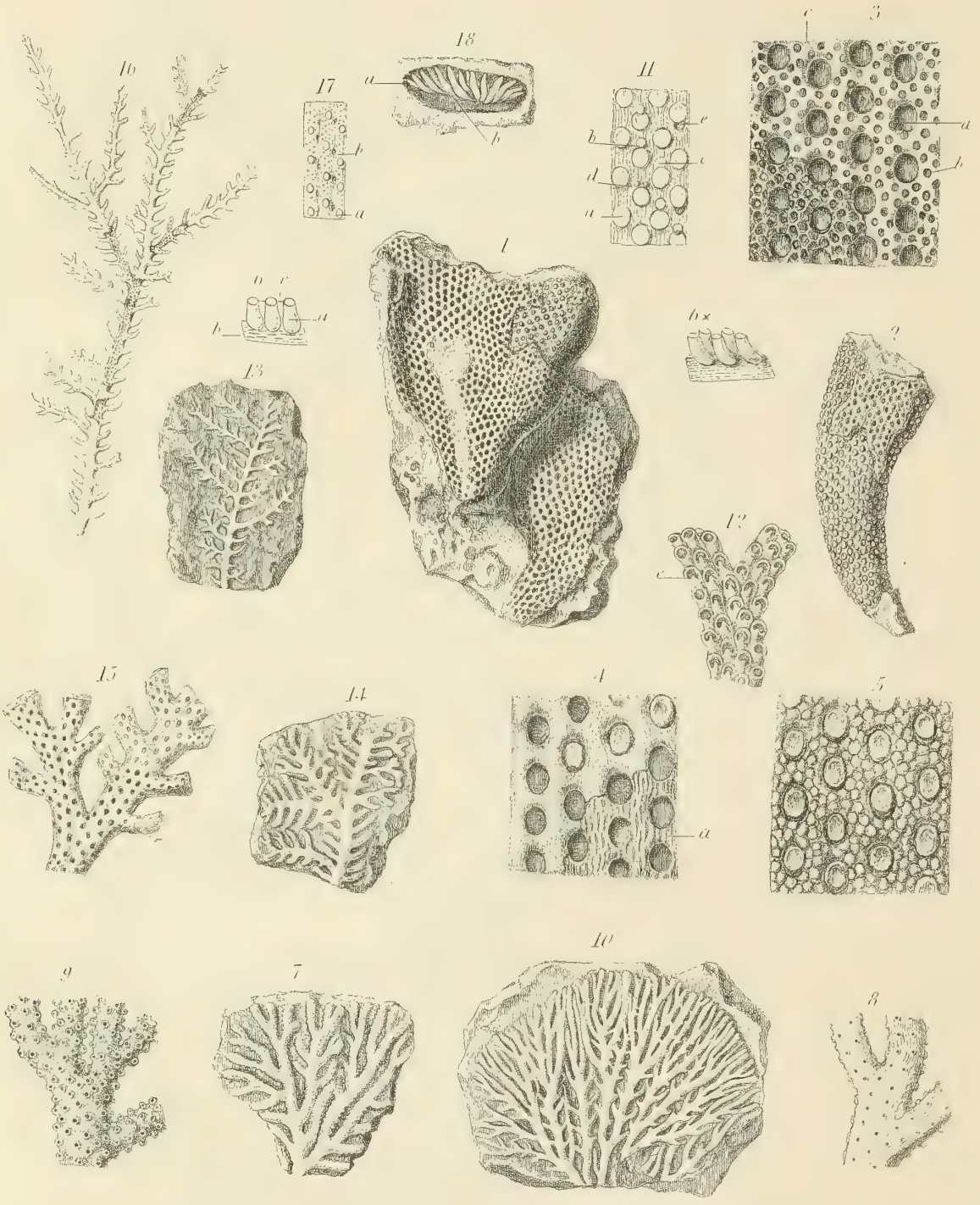

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PLATE V.

Fig.

1. Phyllopora Ehrenbergi, *Geinitz*. Non-celluliferous surface of a specimen, represented of the natural size. Silksworth.

2. — — A little enlarged. The upper part at the right side exhibits the outer or celluliferous surface; the lower portion is an impression of the inner or non-celluliferous surface. Silksworth.

3. — — Highly-magnified view of celluliferous surface, showing meshes (*a*); cellule-apertures (*b*); and cellule-interstices (*c*). At the left lower corner the surface of the coral or cellule-interstitial layer is removed, thereby showing the polygonal form of the cellules near their base. Tunstall Hill.

4. — — Highly-magnified view of the non-celluliferous surface marked (on the upper part of the figure) with fine, waved, longitudinal striæ. At the right lower corner the striated surface is removed, disclosing the layer of vertical capillary tubes (*a*). Tunstall Hill.

5. — — Highly-magnified figure, showing the polygonal form of the cellules at their base, the layer of vertical capillary tubes being removed. Silksworth.

6. — — Diagram showing the form and position of the cellules (*a*): *b*, the basal plate; *c*, the cellule-interstices.

6*. This figure is cancelled.

7. Thamniscus dubius, *Schlotheim*. Twice the natural size. Non-celluliferous surface. Humbleton Hill.

8. — — Portion of the last, highly magnified, showing the foramina and waved longitudinal striæ.

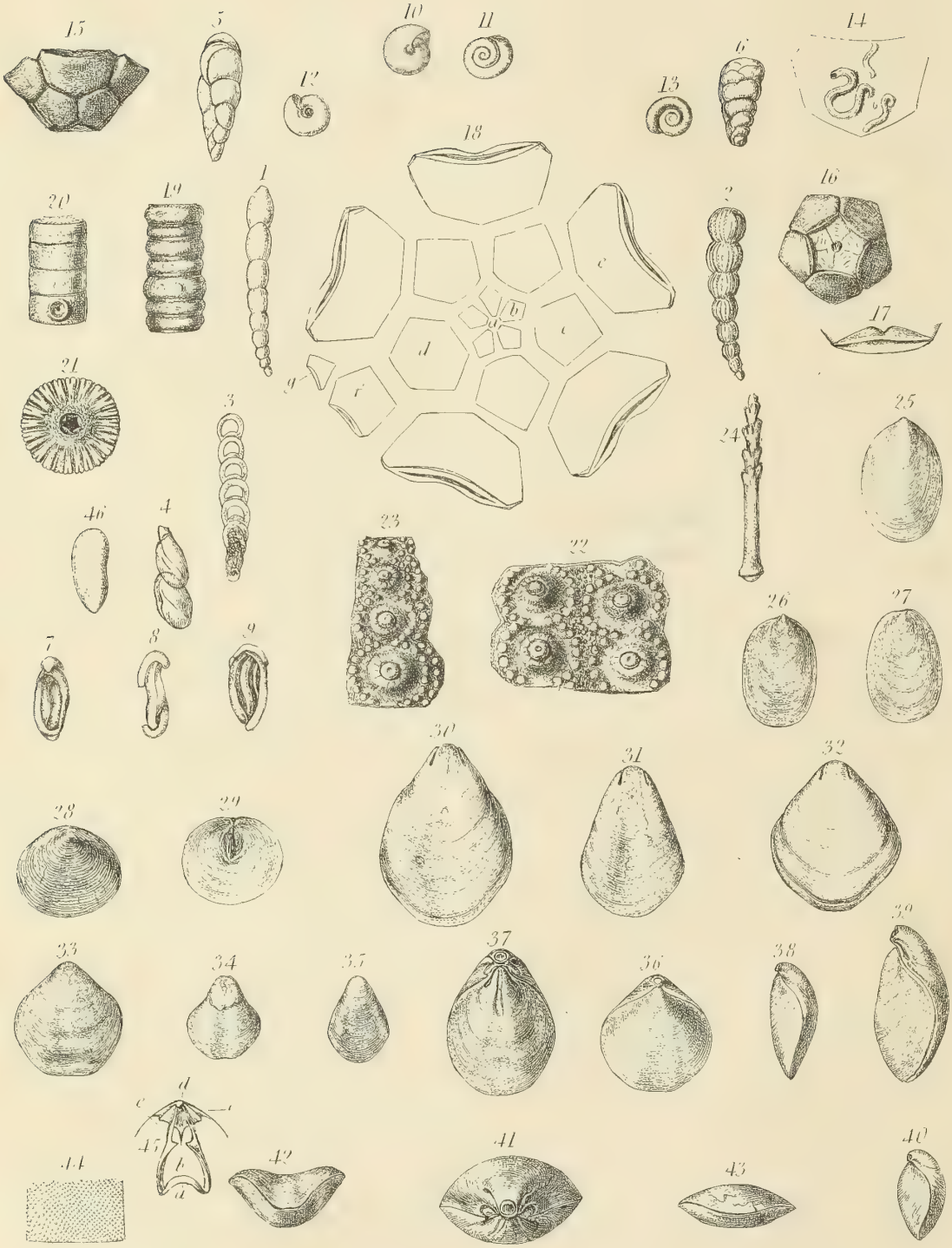
9. — — Highly-magnified view of the celluliferous surface of a specimen, showing the cellule-apertures. Tunstall Hill.

10. — — Specimen, a little enlarged, of a variety with the stems and branches conjoined. Tunstall Hill.

11. — — Highly-magnified view of the natural impression of a branch, showing impressions of the cellule-apertures (*a*); the gemmuliferous vesicles (*b*); annular impressions of the mouths of the latter (*c*); impressions of accessory vesicles (*d*); impressions of the mucro or denticle-like process (*e*) beneath the cellule-apertures; and strong, waved, longitudinal lines on the cellule-interstices. Humbleton Hill.

Fig.

12. Thamniscus dubius, *Schlotheim*. Portion of a branch, highly magnified, showing the mucro or denticle-like process (*e*) on the proximal lip of the cellule-apertures. Tunstall Hill.
13. Acanthocladia anceps, *Schlotheim*. Figure a little enlarged. Humbleton Hill.
14. — — Twice the natural size. Humbleton Hill.
15. — — Magnified view, showing the cellule apertures. The surface of the specimens is rather abraded. Humbleton Hill.
16. — — Non-celluliferous surface. The dotted portions are impressions of the celluliferous surface, the coral being removed. Humbleton Hill.
17. — — Highly-magnified view of a natural impression of the celluliferous surface of a stem, exhibiting impressions of the cellule-apertures (*a*), (?) gemmuliferous vesicles (*b*), and foramina. Humbleton Hill.
18. — — Transverse section (highly magnified) of a branch, showing casts of the cellules (*a*), and a vacancy left by the removal of the basal plate (*b*). Humbleton Hill.



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TAB. VI.

Fig.

1. Dentalina Permiana (× 26).
2. Dentalina Kingii (× 30).
3. Dentalina Kingii (× 30). A longitudinal section, rather on one side of the median line.
4. Dentalina (?) (× 32).
5. Textularia Triticum (× 24). Shell seen obliquely.
6. Textularia cuneiformis (× 34). Shell seen in profile, edge or back view of one row of cells being shown.
7. Serpula (?) pusilla (× 10). Nearly perfect.
8. — — ,, Part of the outer coil.
9. — — ,, Perfect.
10. Spirorbis helix, *King*. Gutta-percha cast of the upper or free side of an impression on a *Productus horridus;* thrice the natural size. Humbleton Hill.
11. — — Natural cast of the attached side on the same shell as the last.
12. Spirorbis Permianus, *King*. Upper or free side, thrice the natural size. Byers's Quarry.
13. — — Attached side, thrice the natural size. Byers's Quarry.
14. Vermilia obscura, *King*. Thrice the natural size. Attached to one of the cup-plates of *Cyathocrinus ramosus*. Tunstall Hill.
15. Cyathocrinus ramosus, *Schlotheim*. Side view of the cup, twice the natural size. Tunstall Hill.
16. — — Basal view of ditto, showing pelvic and costal plates.
17. — — Articulating surface of scapular plates, enlarged.
18. — — Diagram showing the plates separated: *a*, canal; *b*, pelvic plates; *c*, costal plates; *d*, modified costal plate; *e*, scapular plates; *f*, supplementary scapular plate; *g*, superadded scapular plate.
19. — — Beaded internodes of the column, twice the natural size. Tunstall Hill.
20. — — Plane internodes enlarged, showing attachment-scar of a branch. Humbleton Hill.
21. — — Articulating surface of an internode (twice the natural size), showing the pentagonal canal, &c.

Fig.

22. Palæchinus Verneuiliana, *King*. Specimen, thrice the natural size, showing two rows of interambulacral plates. Humbleton Hill.

23. — — Thrice the natural size. Tunstall Hill.

24 (?) . . . . . Muricated spine of probably *Palæchinus Verneuiliana*. Humbleton Hill. Mr. G. Tate's specimen.

25. Lingula Credneri, *Geinitz*. Specimen (twice the natural size) of the large valve. (This specimen shows the true form of the valve.) Marl-slate, Thickley.

26. — — Same valve as last, twice the natural size. Marl-slate, Thrislington Gap.

27. — — Small valve, twice the natural size. Marl-slate, Thrislington Gap.

28. Discina speluncaria, *Schlotheim*. Upper valve, a little enlarged, attached to a *Productus horridus*. Garmundsway.

29. — — Under or attached valve, twice the natural size. Thrislington Gap.

30. Epithyris elongata, *Schlotheim*.
31. — —
32. — —
33. — —
34. — —
35. — —

Large valve, natural size, showing variations of the species. Specimens at figs. 30, 31, 32 are casts from Humbleton Hill. Figs. 33, 34, 35 represent testiferous specimens from Tunstall Hill.

36. — — Small valve of specimen at fig. 33.

37. — — Small valve of a cast from Humbleton Hill.

38. — — Lateral view of specimen at fig. 33, &c.

39. — — Lateral view of specimen at fig. 31.

40. — — Lateral view of a testiferous specimen. Humbleton Hill.

41. — — Umbonal view of a cast. Humbleton Hill.

42. — — Frontal view of a specimen from Tunstall Hill.

43. — — Frontal view of specimen at fig. 33, &c.

44. — — Punctations of the shell, highly magnified, of specimen at fig. 42.

45. — — View of the apophysary system, twice the natural size: *a*, loop; *b*, crural base; *c*, sockets; *d*, boss or cardinal muscular fulcrum; *e*, crura of the loop. Humbleton Hill.

(The letter *b* should have been connected with the pointed part proceeding from the centre of the hinge.)

46. Cythere Geinitziana (× 15).

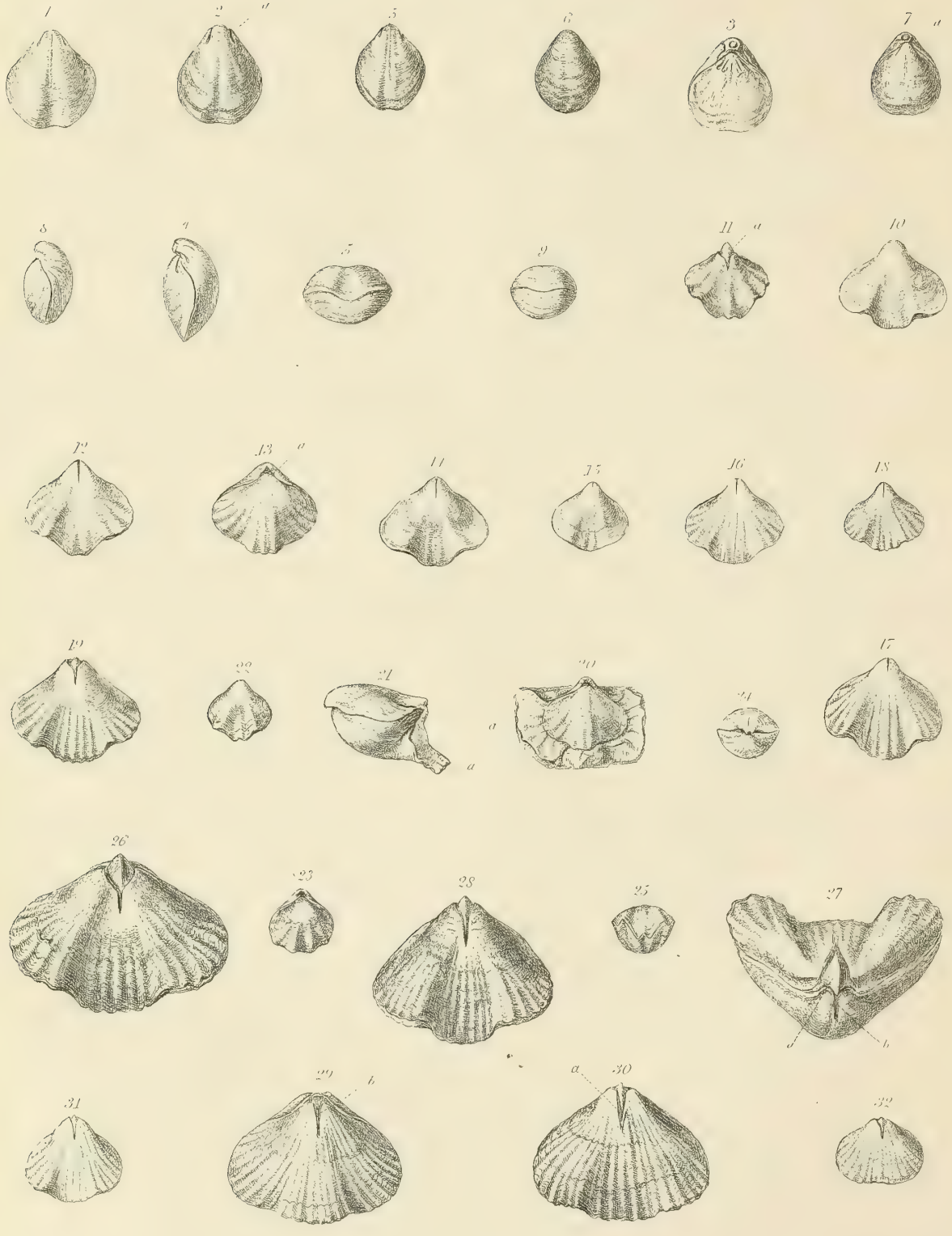

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PLATE VII.

Fig.

1. Epithyris sufflata, *Schlotheim.* Dorsal aspect; cast, natural size. Humbleton Hill.
2. — — Cast. Dorsal aspect, natural size: *a*, impressions of the dental plates. Humbleton Hill.
3. — — Ventral aspect of specimen at fig. 2.
4. — — Lateral aspect of specimen at fig. 1.
5. — — Frontal aspect of specimen at fig. 2.
6. — — Dorsal aspect of a testiferous specimen, natural size. Tunstall Hill.
7. — — Ventral aspect of a testiferous specimen, natural size: *a*, foramen. Tunstall Hill.
8. — — Lateral aspect of specimen at fig. 6.
9. — — Frontal aspect of specimen at figs. 6, 8.
10. Cameraphoria Schlotheimi, *Von Buch.* Dorsal aspect of a specimen entirely without ribs. Tunstall Hill.
11. — — Dorsal aspect. Variety with one rib in the sinus; cast: *a*, cast of the arch. Humbleton Hill.
12. — — Dorsal aspect of a testiferous specimen. Var. with two ribs in sinus. Tunstall Hill.
13. — — Ventral aspect of last specimen: *a*, open fissure.
14. — — Dorsal aspect of a two sinus-ribbed specimen without lateral ribs. Tunstall Hill.
15. — — Dorsal aspect of a young specimen of last variety. Tunstall Hill.
16. — — Dorsal aspect. Var. with three ribs in sinus. Tunstall Hill.
17. — — Dorsal aspect. Var. with four ribs in sinus. Tunstall Hill.
18. — — Dorsal aspect of a young specimen of last variety. Tunstall Hill.
19. — — Dorsal aspect. Var. with five ribs in sinus. Tunstall Hill.
20. — — Ventral aspect (natural size) of a specimen, with lateral marginal expansions (*a*). Tunstall Hill.
21. — — Lateral aspect (natural size) of another specimen, with frontal marginal expansions (*a*). Tunstall Hill.

(All the figures are of the natural size. The Tunstall Hill specimens are testiferous.)

PLATE VII.

Fig.

22. Cameraphoria globulina, *Phillips*. Dorsal aspect, natural size: testiferous. Tunstall Hill.
23. — — Ventral aspect of last specimen.
(The fissure is triangular, and not rounded as represented.)
24. — — Umbonal aspect of last specimen.
25. — — Frontal aspect of last specimen.
26. Cameraphoria multiplicata, *King*. Dorsal aspect of a cast, natural size. Humbleton Hill.
27. — — Umbonal aspect, showing cast of arch (*a*), and impression of the plate (*b*), supporting the spatula-shaped process. Humbleton Hill.
28. — — Dorsal aspect, natural size, of a cast. Humbleton Hill.
29. — — Ventral aspect, natural size, of a cast, showing impression of the plate (*b*), supporting the spatula-shaped process. Humbleton Hill.
30. — — Dorsal aspect of last specimen, showing cast of the arch (*a*).
31. — — Dorsal aspect, natural size, of a young specimen: cast. Humbleton Hill.
32. — — Dorsal aspect of another young specimen: cast. Humbleton Hill.

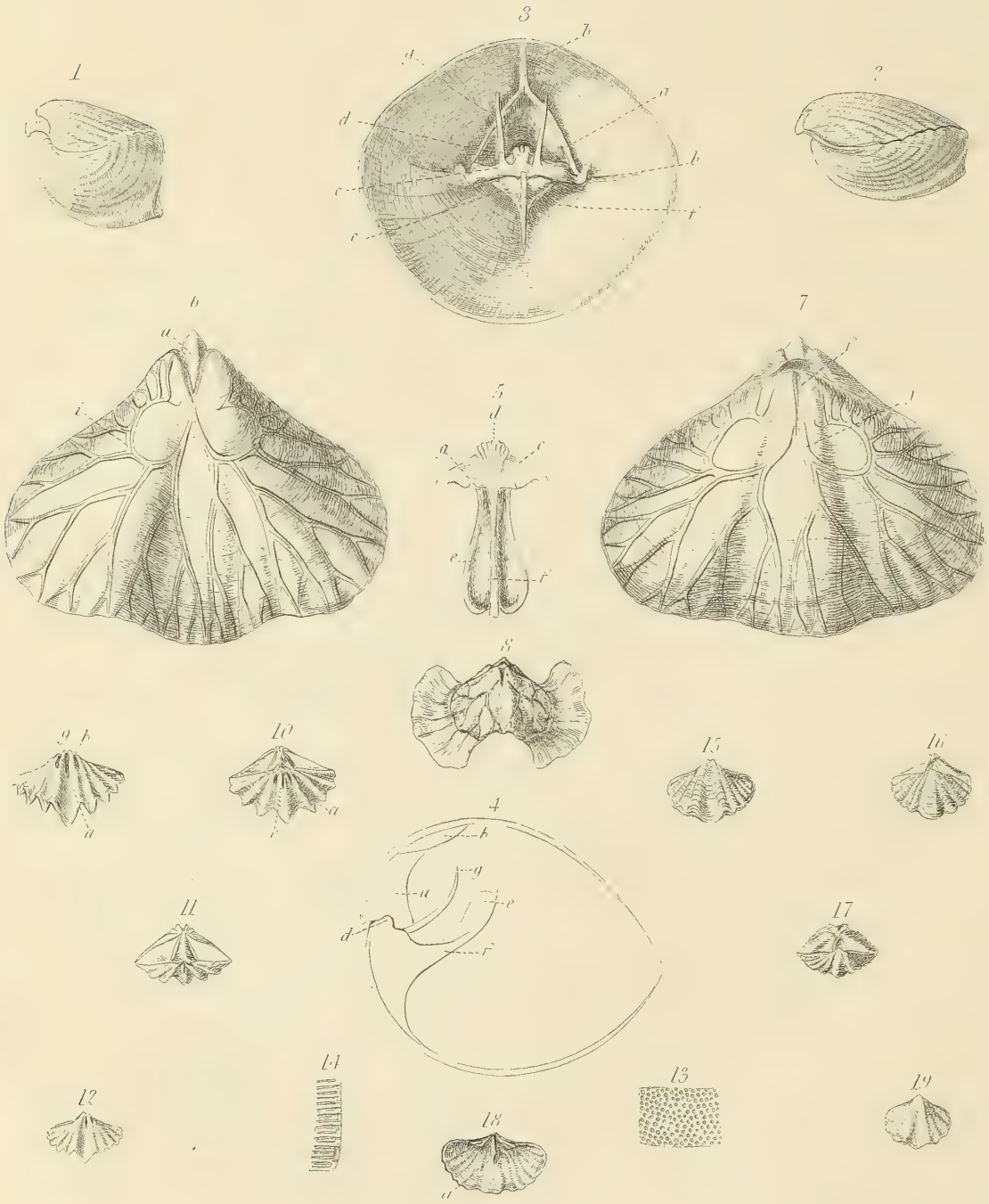

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PLATE VIII.

Fig.

1. Camaraphoria multiplicata, *King*. Lateral aspect, of a short variety; cast, natural size. Humbleton Hill.
2. — — Lateral aspect of the specimen represented by figs. 29, 30, in Plate VII.
3. — — Internal view (partly restored), showing plates of the arch (*a*); supporting plate of do. (*b*); crural base or platform (*c*); boss or cardinal muscular fulcrum (*d*); spatula-shaped process (*e*); supporting plate of do. (*f*); spurs or crura (*g*); socket-plates (*h*). Highly magnified.
   (The socket-plates have inadvertently been marked *b*.)
4. — — Diagram of a longitudinal section of the shell exhibiting the different internal structures, as lettered in the last figure.
5. — — Enlarged view of the platform, spatula-shaped process, &c., looking down on them. The letters in the last figures refer to the same structures. Letter *g* simply represents the origin of the spurs. The upper edge of the plate supporting the spatula-shaped process is indicated by letter *f*.
6. — — Enlarged view of the large valve, showing cast of the arch (*a*), and impressions of the veins (*i*). Humbleton Hill.
7. — — Enlarged view of the small valve, showing cast of the plate supporting the spatula-shaped process (*f*), and impressions of the arteries (*j*) within the veins. Humbleton Hill.
8. Camaraphoria Schlotheimi, *Von Buch*. Figure (natural size) of a cast showing lateral marginal expansions, and impressions of the vascular system. Humbleton Hill.
9. Trigonotreta cristata, *Schlotheim*. Cast of the large valve, natural size: *a*, impression of the ventral median plate; *b*, impressions of the dental plates. Humbleton Hill.
10. — — Cast of the small valve, natural size: *a*, impressions of the socket plates; *c*, impression of dorsal median plate. Humbleton Hill.

PLATE VIII.

Fig.

11. Trigonotreta cristata, *Schlotheim*. Cast showing area and fissure, natural size. Humbleton Hill.
12. — — Young specimen. Humbleton Hill.
13. — — Enlarged view of the test, showing openings of the punctures.
14. — — Longitudinal section of the test, highly magnified, showing casts of the punctures.
15. Trigonotreta multiplicata, *J. de C. Sowerby*. Testiferous specimen, a little enlarged, of large valve. Tunstall Hill.
16. — — Small valve of last specimen.
17. — — View of the area and fissure of the last.
18. — — Interior of the large valve, showing the ventral median plate (*a*). Tunstall Hill.
19. Trigonotreta Jonesiana, *King*. Large valve of a young specimen, twice the natural size. Ryhope Field-House Farm.

PLATE IX.

Fig.

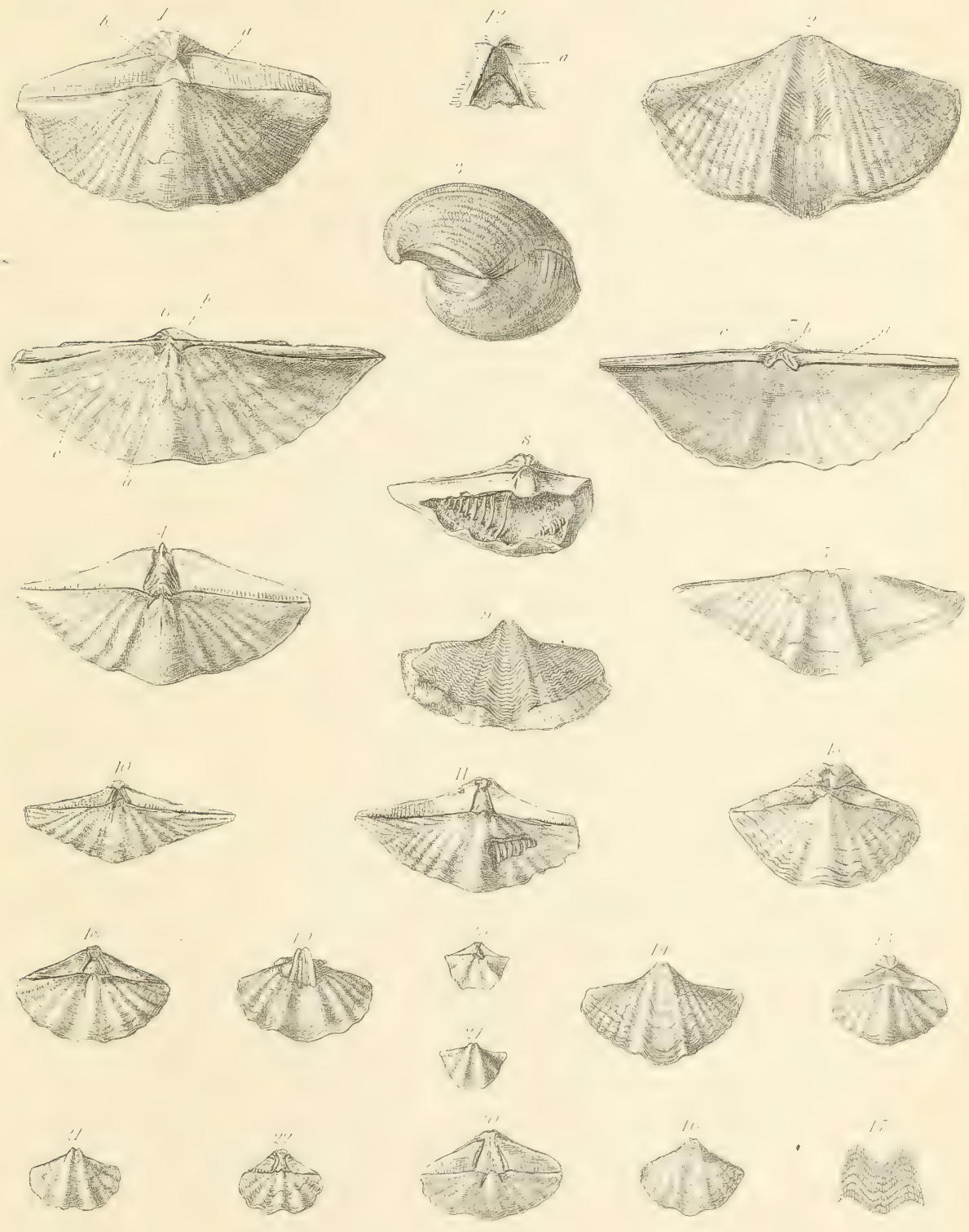
1. Trigonotreta undulata, *J. de C. Sowerby*. Testiferous specimen, natural size, showing area (*a*), and fissure or deltidium (*b*). Midderidge.

   (This beautiful specimen, which is the original of the figure in the 'Mineral Conchology' (Pl. 562, fig. 1), has been kindly lent me by its owner, Mr. J. de C. Sowerby, for illustration. I have carefully removed some of the investing matrix, thereby showing certain parts more distinctly than in the figure just cited.)

2. — — Large valve of the same specimen.
3. — — Lateral aspect of the same.
4. Trigonotreta alata, *Schlotheim*. Cast, natural size, showing area, fissure, and small valve. Humbleton Hill.
5. — — Cast (natural size) of the large valve. Humbleton Hill.
6. — — Cast (natural size) of the small valve, showing impressions of the anterior division of the valvular muscles (*a*); posterior division of the same (*b*); and vascular system (*c*). Humbleton Hill.
7. — — Gutta-percha cast of the last specimen, showing area (*a*); excavated (? cardinal) muscular impressions (*b*); and origin of the crura of the spirals (*c*).
8. — — Cast, natural size, showing one of the spiral coils. Humbleton Hill.
9. — — Testiferous specimen, natural size, showing laminæ of growth. Midderidge.
10. — — Cast of a young specimen, rather enlarged, showing ribs parallel to the hinge-line. Humbleton Hill.
11. — — Cast, natural size. Humbleton Hill.
12. — — Gutta-percha cast of the medial region of the area, showing the fissure closed inwardly by an arch-shaped plate.

    (The lower cone-like portion bounded by the dark line, should not have been represented as it is foreign matter).

13. Trigonotreta undulata, *J. de C. Sow.* Specimen, natural size, with the shell partially removed. Humbleton Hill.
14. — — Cast, natural size. Humbleton Hill.
15. — — Testiferous specimen, natural size. Tunstall Hill.
16. — — Young specimen, rather enlarged. Tunstall Hill.
17. — — Portion of the shell, highly magnified, showing the laminæ to consist of capillary fibres. Tynemouth Cliff.
18. Trigonotreta Permiana, *King*. Cast, natural size. Humbleton Hill.
19. — — Cast (natural size) of large valve. Humbleton Hill.
20. — — Cast, natural size. Humbleton Hill.
21. — — Cast (natural size) of large valve. Humbleton Hill.
22. — — Small valve of the last specimen.
23. — — Cast, twice the natural size. Humbleton Hill.
24. — — Large valve of last specimen.



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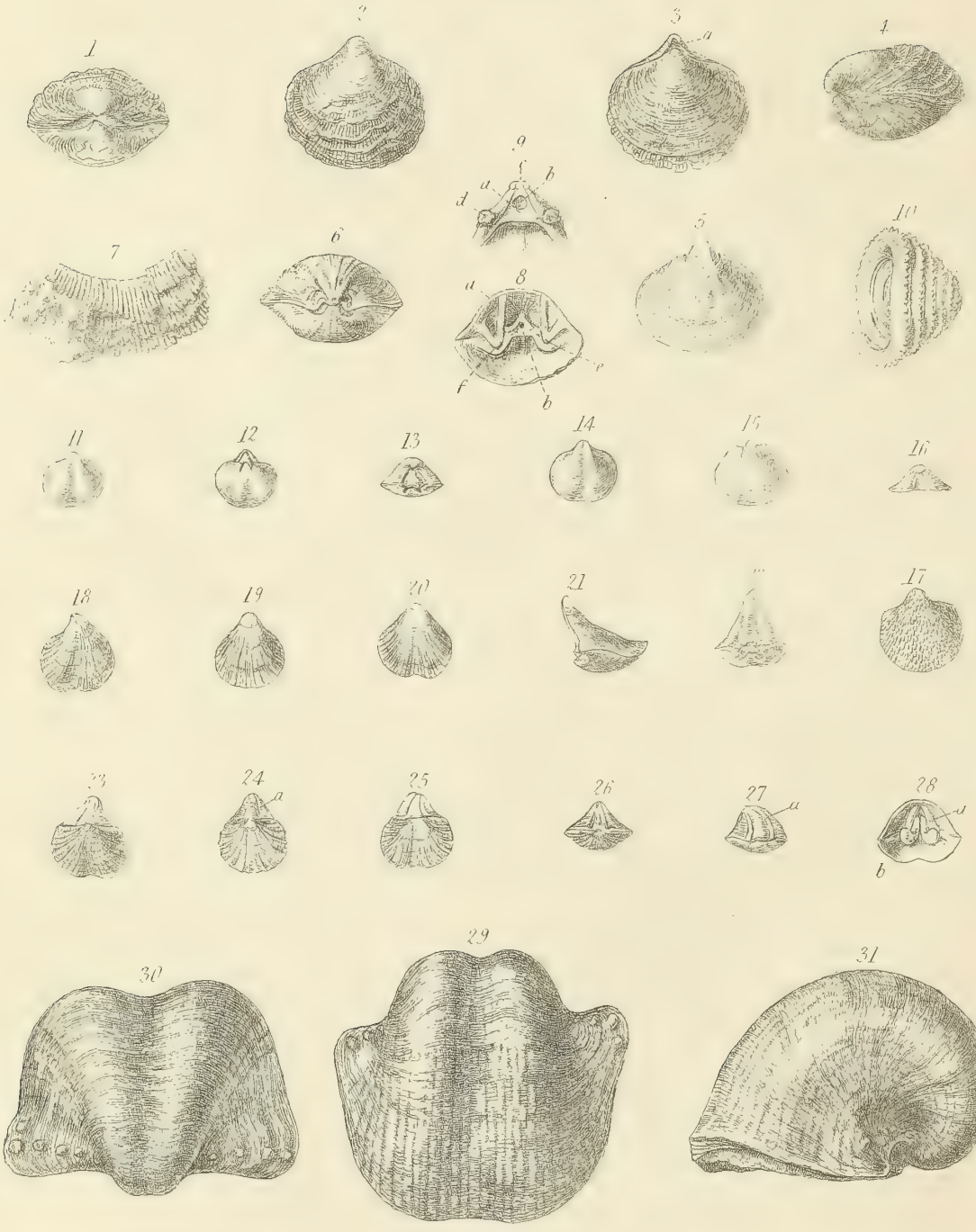

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PLATE X.

Fig.

1. Cleiothyris pectinifera, *J. de C. Sowerby.* Umbonal view (natural size) of a testiferous specimen. Tynemouth Cliff.
2. — — Large valve of last specimen, showing the pectinated expansions.
3. — — Small valve of the same, showing the emarginate foramen (*a*).
4. — — Lateral view of the same, showing the pectinated expansions.
5. — — Cast of large valve, natural size. Humbleton Hill.
6. — — Umbonal view of the last specimen.
7. — — Magnified view of the pectinated expansions.
8. — — Enlarged view of the inside of the posterior half, showing the hinge-structures of both valves: *a*, dental plates; *b*, foramen in the crural base or platform; *e*, teeth; *f*, dental sockets. Humbleton Hill.
9. — — Enlarged view of the hinge-structures of the small valve: *a*, crural base or platform; *b*, foramen in do.; *c*, button or cardinal muscular fulcrum; *d*, origins of the crura of the spirals.
10. — — Enlarged view of one of the spirals, showing it to be fringed on the outer edge. Humbleton Hill.
11. Martinia Clannyana, *King.* Cast, twice the natural size; large valve. Ryhope Field-House Farm.
12. — — Small valve of the last specimen.
13. — — Umbonal view of the same, exhibiting area and fissure.
14. Martinia Winchiana, *King.* Cast (enlarged) of large valve. Whitley.
15. — — Cast (enlarged) of small valve. Whitley.
16. — — Umbonal view, showing area and fissure. Whitley.
17. — — Restoration of the large valve.

(I was formerly of opinion that in this species the valves were covered with radiating hair-like spines; but of late I have been led to think that the characters inducing this opinion, are merely due to the fibrous structure of the shell. It is therefore extremely doubtful that the shell possessed any spines as represented in the restoration.)

Fig.

18. Streptorhynchus pelargonatus, *Schlotheim*. Testiferous specimen (large valve), twice the natural size. Dalton-le-Dale.
19. — — Another specimen, differing in form. Dalton-le-Dale.
20. — — Another variety. Dalton-le-Dale.
21. — — Lateral view (twice the natural size) of a cast. Dalton-le-Dale.
22. — — Cardinal view of the last, showing the area and deltidium.
23. — — } Testiferous specimens, twice the natural size, looking on
24. — — } the small valve and area (*a*). Dalton-le-Dale.
25. — — }
26. — — } Cardinal view (twice the natural size) of other specimens:
27. — — } *a*, the deltidium or closed fissure. Dalton-le-Dale.
28. — — Enlarged view of the posterior half of the shell, showing the dental plates (*a*) and socket-plates (*b*). Tunstall Hill.
29. Productus horridus, *J. de C. Sowerby*. Front view (natural size) of the large valve of a testiferous specimen. Garmundsway.
30. — — Umbonal view of the last specimen.
31. — — Lateral view of the same.

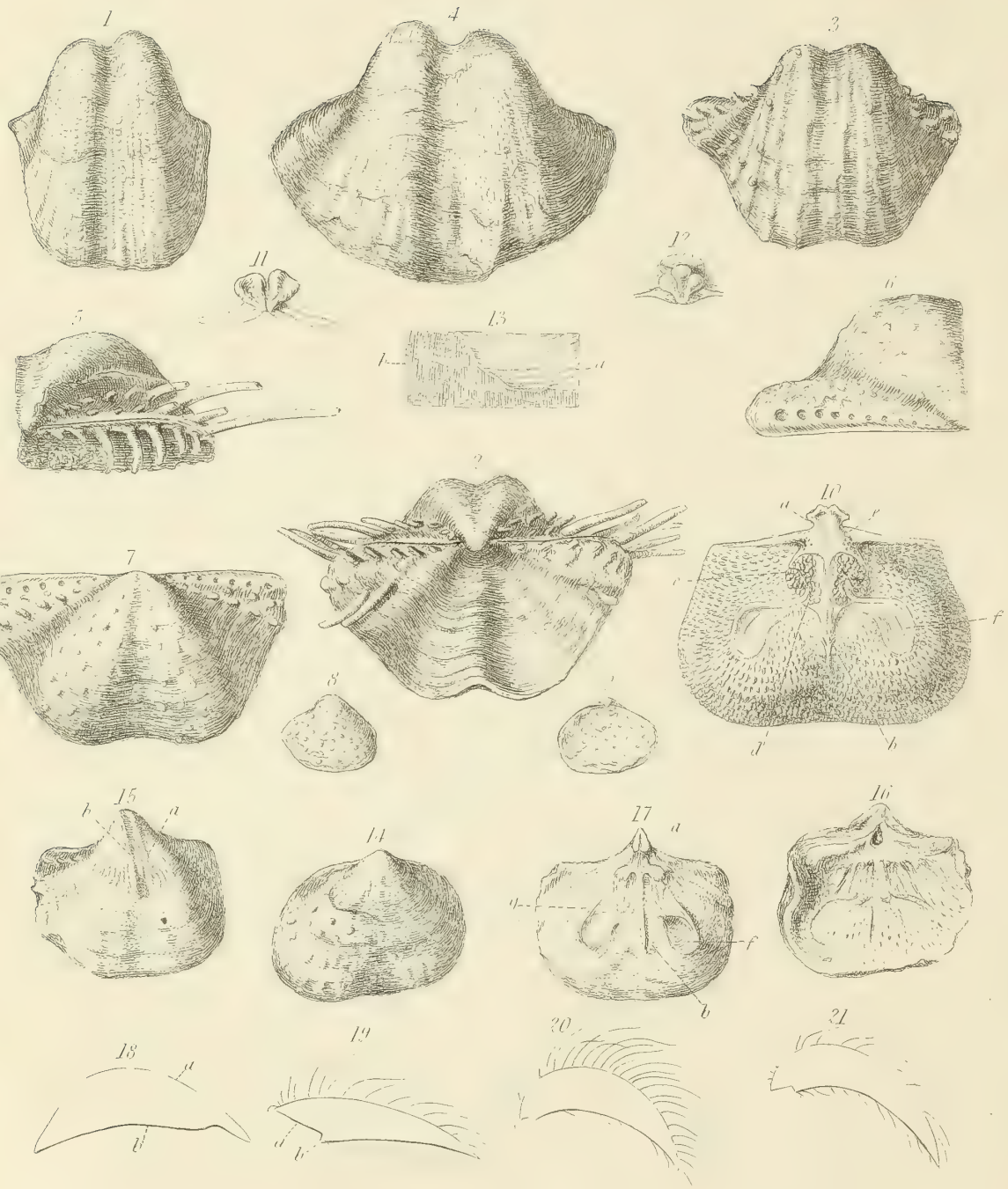

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PLATE XI.

Fig.

1. Productus horridus, *J. de C. Sow.* Testiferous specimen, natural size. Whitley.
2. — — Testiferous specimen, natural size. Derbyshire. Mr. J. de C. Sowerby's specimen—the original of fig. 1 in plate cccxix of the 'Mineral Conchology.'
3. — — Large valve of another testiferous specimen from Derbyshire. Mr. J. de C. Sowerby.
4. — — View of a specimen partially deprived of the shell, natural size. Humbleton Hill.
5. — — Right half of a testiferous specimen, natural size, showing the cardinal spines of both valves. Humbleton Hill.
6. — — Impression of the left half of the small valve, natural size, showing the pits of a single row of cardinal spines. Humbleton Hill.
7. — — Impression of the external surface of the small valves, showing abortive spines. Humbleton Hill.
8. — — Large valve, a little enlarged, of a young (testiferous) specimen. Tynemouth Cliff.
9. — — Small valve of the last specimen, showing bases of the spines.
10. — — Gutta-percha cast of the small valve (inner surface), showing the boss or cardinal muscular fulcrum (*a*); median plate (*b*); posterior division of the valvular muscular impressions (*c*); anterior division of ditto (*d*); (?) impressions of the inferior pedicle muscles (*e*); reniform impressions (*f*). The original is from Humbleton Hill.
11. — — Gutta-percha cast of the cardinal boss of a specimen from Humbleton Hill. Twice the natural size.
12. — — Cardinal boss of a specimen from Garmundsway.
(The upper part of the figure is foreign matter.)
13. — — Magnified representation of the structure of the shell: *a*, external surface of the shell, exhibiting lines of growth: *b* represents the external layer removed, thereby exposing the under fibrous layer. Mr. J. de C. Sowerby's specimen, from Derbyshire.
14. Productus umbonillatus, *King.* Convex valve, natural size, with a portion of the shell, showing bases of spines. Tunstall Hill.

Fig.

15. Productus umbonillatus, *King*. Cast (natural size) of the convex valve, showing impressions of the superior pedicle muscles (*a*), and of the valvular and cardinal ditto (*b*) conjoined. Tunstall Hill.

(The letter *a* points too much to the left.)

16. — — Small valve of the last specimen.

17. — — Gutta-percha cast of the flat valve of the same, showing the boss or cardinal muscular fulcrum (*a*); median plate (*b*); reniform impressions (*f*); impression of a vein connecting the latter structures with the medio-cardinal region (*g*).

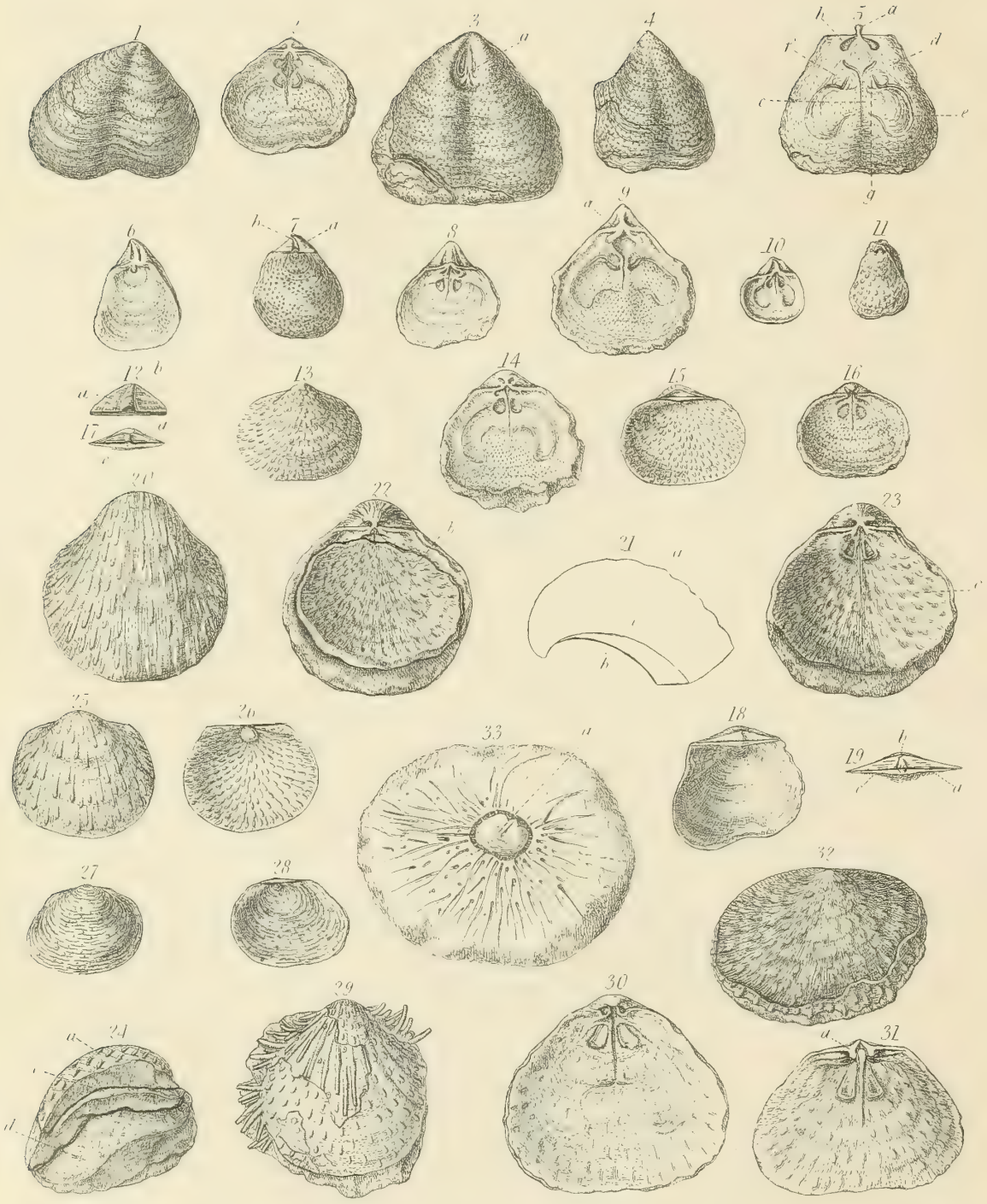
(The dotted line connecting the letter *a* with the boss has been inadvertently omitted.)

18. — — Medio-longitudinal section: *a*, large valve; *b*, small valve. The inferior side of the prolongation (umbone) on the right side of the figure represents the flattened (or area-like) space on that side of the umbone adjoining the hinge.

19. Strophalosia Goldfussi, *Münster*. Ideal medio-longitudinal section: *a*, area of large valve; *b*, ditto of small valve.

20. Strophalosia excavata, *Geinitz*. Ideal medio-longitudinal section.

21. Strophalosia Morrisiana, *King*. Ideal medio-longitudinal section.



G.B. Sowerby Jun.r

PLATE XII.

Fig.

1. Strophalosia Goldfussi, *Münster*. Cast, large valve, natural size. Ryhope Field-House Farm.
2. — — Cast, small valve, natural size. Ryhope Field-House Farm.
3. — — Cast, large valve, natural size: *a*, Cardinal and valvular muscular scars confluent. Humbleton Hill.
4. — — Cast, large valve, natural size. Ryhope Field-House Farm.
5. — — Representation (copied from a gutta-percha cast of fig. 9) of inner surface of small valve, showing boss or cardinal muscular fulcrum (*a*); dental sockets (*b*); median plate (*c*); impression of vein connecting the reniform lobes with the medio-cardinal region (*d*); reniform lobes (*e*); posterior division of the valvular muscles (*f*); anterior division of the same (*g*).
6. — — Cast (natural size) of small valve, and area of large valve Ryhope Field-House Farm.
7. — — Testiferous specimen. Same view (natural size) as last: *a*, area; *b*, deltidium. Ryhope Field-House Farm.
8. — — Cast, same view (natural size) as last. Humbleton Hill.
9. — — Cast, natural size, showing depressions of the teeth of the large valve (*a*). Humbleton Hill.
10. — — Cast of a young specimen. Humbleton Hill.
11. — — Cast (nearly twice the natural size) of a young specimen. Ryhope Field-House Farm.
12. — — Gutta-percha cast of the area (*a*), and deltidium (*b*) of the large valve. Original from Ryhope Field-House Farm.
13. Strophalosia excavata, *Geinitz*. Gutta-percha cast of the large valve, natural size, showing the spines. Original from Dalton-le-Dale.
14. — — Cast, small valve. Humbleton Hill.
15. — — Gutta-percha cast of small valve (crowded with spines), and areas. Dalton-le-Dale.
16. — — Cast, small valve. Humbleton Hill.
17. — — Gutta-percha cast of area of both valves: *a*, large valve; *c*, small valve. Original from Dalton-le-Dale.
18. Strophalosia Morrisiana, *King*. Small valve (natural size) of a testiferous specimen. Tunstall Hill.

(The spines are preserved on the large valve only).

Fig.

19. Strophalosia Morrisiana, *King*. Enlarged view of the posterior part of the last specimen, showing the area of the large valve (*a*), with its deltidium (*b*), and the area of the small valve (*c*).
(Letter *a* should have pointed to the upper area).

20. — — Cast, natural size, large valve. Humbleton Hill.

21. — — Ideal medio-longitudinal section of the last specimen, showing it to be tri-valved: *a*, large valve; *b*, small valve; *c*, inner valve.

22. — — Same specimen as fig. 20, exhibiting impression of the inner surface of the small valve (*b*).

23. — — Same specimen, with the part (*b*) of the last figure removed, thereby disclosing the impression of the inner valve (*c*).

24. — — Another tri-valved specimen. Cast, natural size: *a*, inner surface of large valve; *c*, inner valve; *d*, impression of the outer surface of the small valve. Humbleton Hill.

25. — — Cast, large valve, natural size. Humbleton Hill.

26. — — Gutta-percha cast of the outer surface of the small valve, showing the spines. Original from Whitley.

27. — — Large valve of a young specimen, magnified four times. Tynemouth Cliff.

28. — — Small valve of last specimen, showing bases of spines.

29. — — Large valve, natural size, with portions of the test remaining where the spines are preserved. Humbleton Hill.

30. — — Cast, natural size, ventral valve. Humbleton Hill.

31. — — Gutta-percha cast (natural size) of small valve with the hinge-plate of the large valve attached to it: *a*, teeth of the large valve inserted in the sockets (which are not so clearly exhibited as could be desired) on each side of the median plate of the small valve. Original from Humbleton Hill.

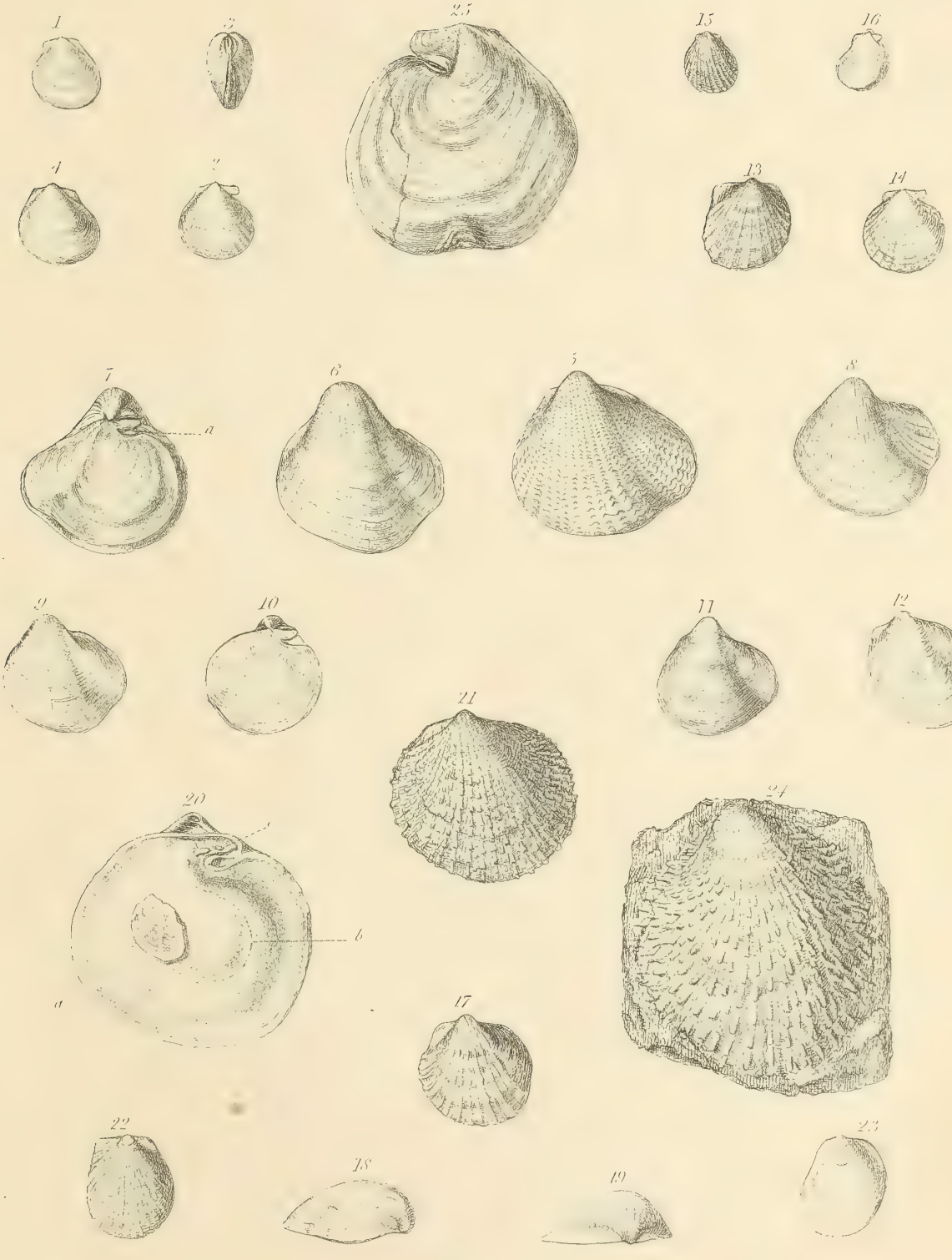
32. — — Cast, natural size, small valve. Humbleton Hill.

33. Strophalosia parva, *King*. Cast (rather larger than the original) adhering by its spines to the inner surface of the large valve of a *Productus horridus*. Humbleton Hill.
(The outline of the Productus is not represented on account of the want of space. The letter *a* points to the umbone of the Strophalosia).

PLATE XIII.

Fig.

1. Pecten pusillus, *Münster*. Cast of upper valve, natural size. Humbleton Hill.
2. — — Cast of under valve, natural size. Humbleton Hill.
   (The radiating longitudinal lines on the fossil figured, are due to a *condition* of fossilization.)
3. — — Lateral view of a cast, natural size. Humbleton Hill
4. Lima Permiana, *King*. Left valve (testiferous), natural size. Humbleton Hill.
5. Monotis speluncaria, *Schlotheim*. Cast of upper valve, natural size. Humbleton Hill.
6. — — Cast of upper valve, natural size. Humbleton Hill.
7. — — Cast of the last specimen, showing byssal notch (*a*).
8. — — Cast of upper valve, natural size. Humbleton Hill.
9. — — Cast of upper valve, natural size. Humbleton Hill.
10. — — Under valve of last.
11. — — Upper valve of a smooth (testiferous) variety, natural size. Tunstall Hill.
12. — — Upper valve of a dextrally-oblique variety. Cast, natural size. Humbleton Hill.
13. — — Upper valve (testiferous) of a sinistrally-oblique variety, natural size. Tunstall Hill.
14. — — Outer surface of a flat valve (testiferous), showing radiating longitudinal lines; enlarged. Tunstall Hill.
15. — — Upper valve of a young testiferous specimen. Twice the natural size. Tunstall Hill.
16. — — Under valve of the same shell.
17. — — Cast of upper valve, natural size. Humbleton Hill.
18. — — Lateral view of specimen at figs. 9, 10.
19. — — Umbonal view of the same.
20. — — Cast of under valve (natural size) showing impressions of the adductor muscle (*a*), pallial line (*b*), and pedal muscles (*c*). Humbleton Hill.
21. — — Testiferous specimen. Upper valve, natural size. Silksworth.
22. Monotis radialis, *Phillips*. Cast of upper valve, natural size. Humbleton Hill.
23. — — Cast (natural size) of the upper valve of a smooth variety. Humbleton Hill.
    (The margin of the original is not entire.)
24. Monotis Garforthensis, *King*. Testiferous specimen. Upper valve, natural size. Garforth.
    (The specimen is in the Museum of the Yorkshire Philosophical Society.)
25. Monotis . . . . . ? Testiferous specimen exhibiting the inner surface of the under valve, natural size. Garforth. Mr. E. Charlesworth's specimen.



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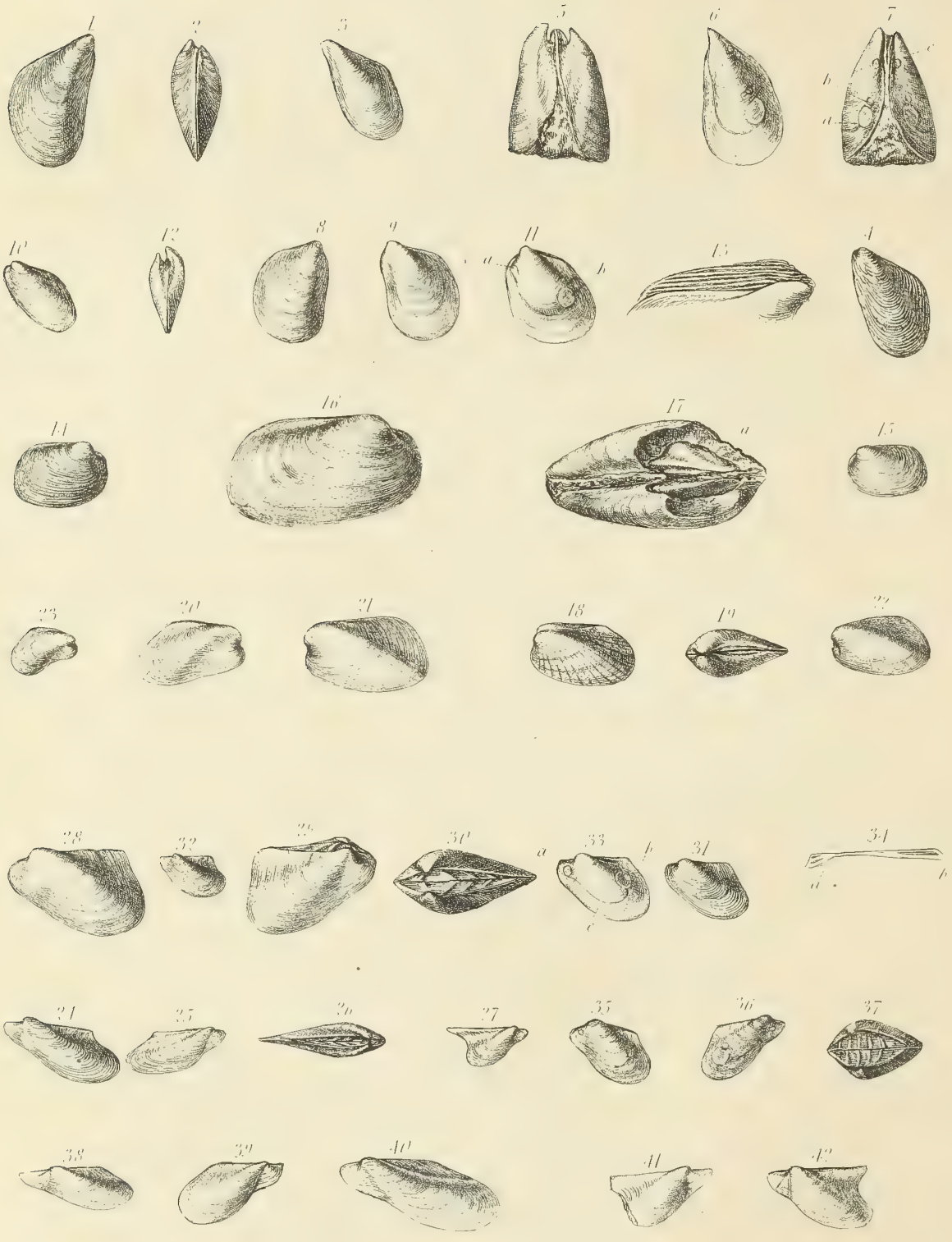


G.B. Sowerby Junr

PLATE XIV.

Fig.

1. Mytilus squamosus, *J. de C. Sow.* Right valve (natural size) of a testiferous specimen. Tunstall Hill.
2. — — Dorsal aspect of a testiferous specimen, natural size. Tunstall Hill.
3. — — Left valve of a testiferous specimen, natural size. Tunstall Hill.
4. — — Left valve of a testiferous specimen, natural size. Silksworth.
5. — — Dorsal view of a cast, natural size. Humbleton Hill.
6. — — Cast; left valve showing impressions of pallial line, and posterior adductor muscles. Mr. E. W. Binney's specimen.
7. — — Dorsal view of the last specimen, showing impressions of the posterior adductor muscles (*a*); posterior visceral ditto (*b*); and anterior adductor ditto (*c*).
8. Mytilus septifer, *King.* Right valve of a testiferous (smoothed) specimen, natural size. Souterpoint.
9. — — Left valve (natural size) of a testiferous (smoothed) specimen. Souterpoint.
10. — — Left valve; young specimen. Cast, rather enlarged. Roaker Rocks.
11. — — Cast; left valve (natural size) showing impressions of the anterior adductor muscle (*a*); posterior ditto (*b*); and pallial line. Byers's Quarry.
12. — — Ventral view of a cast. Byers's Quarry.
13. — — Cast of the hinge (twice the natural size), showing impressions of the cartilage grooves. Tunstall Hill.
14. Edmondia Murchisoniana, *King.* Right valve (testiferous), natural size. Tunstall Hill.
15. — — Left valve (natural size) of a testiferous specimen. Tunstall Hill.
16. — — Cast; natural size; right valve. Humbleton Hill.
17. — — Dorsal view of the last specimen with the umbones removed, to show the pair of subjacent cartilage fulcra (*a*).
18. Cardiomorpha modioliformis, *King.* Left view of a testiferous specimen, natural size. Tunstall Hill.
19. — — Dorsal view of the same shell.
20. — — Right valve (natural size) of a smooth variety. Tunstall Hill.
21. — — Left valve (natural size) of an angulated variety. Tunstall Hill.

Fig.

22. Cardiomorpha modioliformis, *King*. Cast (natural size) of the left valve, showing impression of the ridge behind the anterior adductor muscular impression. Tunstall Hill.

23. — — Right aspect of a young testiferous specimen. Tunstall Hill.

24. Bakevellia ceratophaga, *Schlotheim*. Left valve (natural size) of a testiferous specimen. Tunstall Hill.

25. — — Right valve (natural size) of a testiferous specimen. Tunstall Hill.

26. — — Cardinal view, rather enlarged, of a testiferous specimen, showing cartilage-grooves. Tunstall Hill.

27. — — Right valve (natural size) of a young (testiferous) specimen. Tunstall Hill.

28. Bakevellia antiqua, *Münster*. Left valve (natural size) of a smoothed testiferous specimen. Tunstall Hill.

29. — — Right aspect of the same shell.

30. — — Cardinal view of the same, showing the cartilage pits.

31. — — Left valve (natural size) of a testiferous specimen marked with striæ of growth. Tunstall Hill.

32. — — Left valve (natural size) of a young (testiferous) specimen. Tunstall Hill.

33. — — Cast (natural size) of left valve, showing impressions of the anterior adductor muscles (*a*); posterior do. (*b*); and pallial line (*c*). Humbleton Hill.

34. — — Enlarged representation of the hinge-plate in gutta percha, showing the anterior teeth (*a*), and posterior do. (*b*). Original from Tunstall Hill.

35. Bakevellia tumida, *King*. Cast (natural size) of the left valve. Humbleton Hill.

36. — — Cast (natural size) of the right valve, showing impressions of the anterior, and posterior adductor muscles, and pallial line. Humbleton Hill. Professor Phillips's specimen.

37. — — Gutta-percha cast (rather enlarged) of the cardinal region, showing the cartilage pits on the area. The original is from Ryhope Field-House Farm.

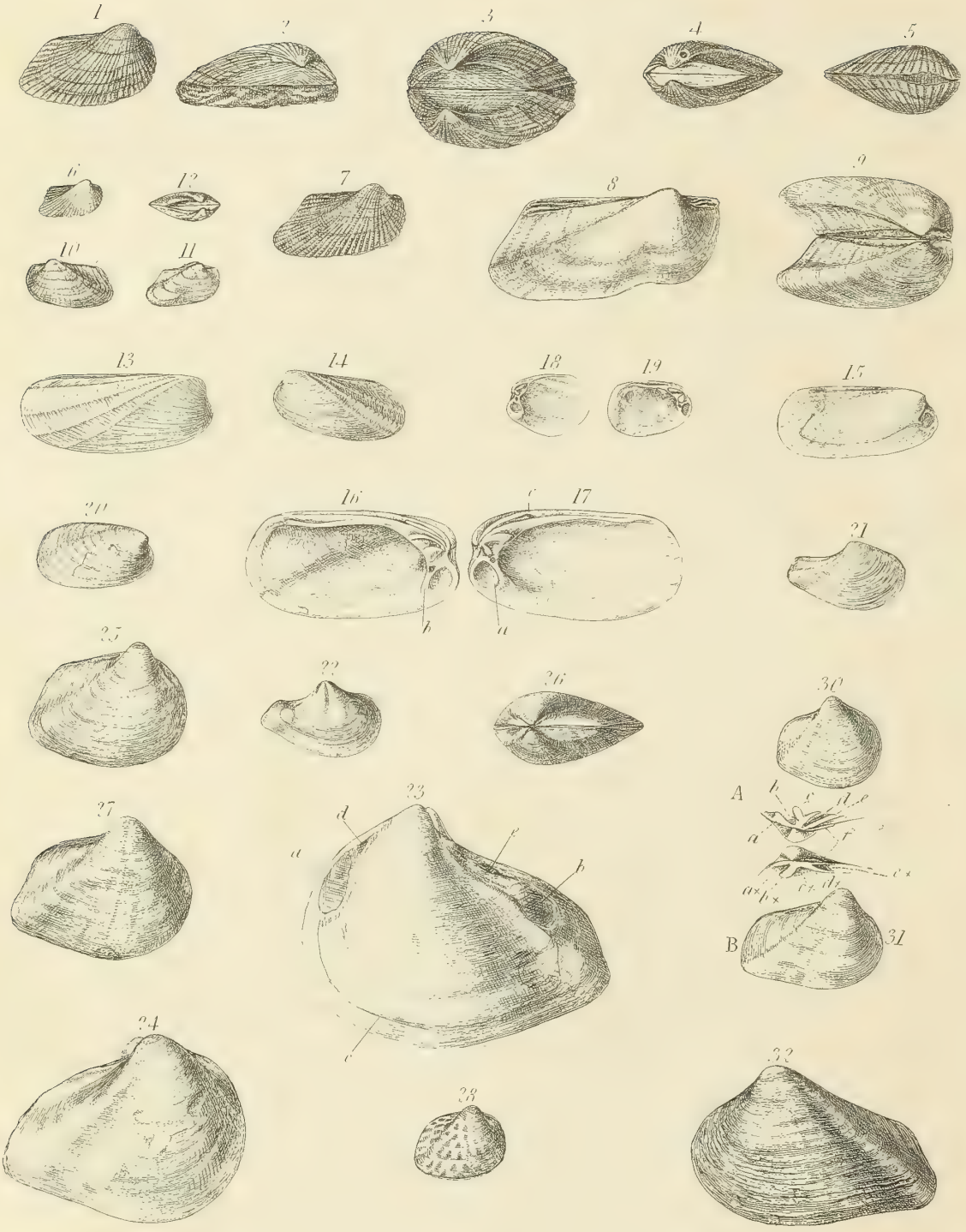
38. Bakevellia Sedgwickiana, *King*. Left valve (natural size) of a testiferous specimen. Tunstall Hill.

39. — — Right valve (natural size) of a testiferous specimen. Tunstall Hill.

40. — — Left valve (natural size) of a testiferous specimen. Tunstall Hill.

41. Bakevellia bicarinata, *King*. Right valve (natural size) of a testiferous specimen. Tunstall Hill.

42. — — Left valve (natural size) of a testiferous specimen. Tunstall Hill.



C.B. Sowerby Junr.

PLATE XV.

Fig.

1. Bysso-arca tumida, *J. Sowerby*. Right aspect of a testiferous specimen, natural size. Tunstall Hill. Belonging to Professor Phillips.
2. — — Umbonal aspect (rather enlarged) of a left valve (testiferous), showing cartilage-grooves on the area. Tunstall Hill.
3. — — Umbonal aspect, natural size. Tunstall Hill.
4. — — Umbonal aspect, natural size. Tunstall Hill.
   (The circular hole in one of the beaks is supposed to have been made by a carnivorous mollusc.)
5. — — Ventral aspect (natural size) of a testiferous specimen, showing byssal opening. Tunstall Hill.
6. — — Right valve, twice the natural size. Tunstall Hill.
7. Bysso-arca striata, *Schlotheim*. Right valve (a little enlarged) of a testiferous specimen. Tunstall Hill.
8. — — Cast of the right valve (natural size), showing impressions of the anterior and posterior teeth. Humbleton Hill. Belonging to Mr. J. de C. Sowerby.
9. — — Cast, natural size. Humbleton Hill.
10. Bysso-arca Kingiana, *de Verneuil*. Left valve of a testiferous specimen, natural size. Tunstall Hill.
11. — — Right valve (twice the natural size) of a testiferous specimen. Tunstall Hill.
12. — — Umbonal view of the same valve.
13. Pleurophorus costatus, *Brown*. Right valve; testiferous, natural size. Tunstall Hill.
14. — — Left valve; testiferous, natural size. Tunstall Hill.
15. — — Cast of a right valve (natural size), showing impressions of the anterior and posterior adductor muscles, and pallial ditto. Humbleton Hill.
16, 17. — — Interior of both valves (twice the natural size), showing anterior adductor muscular impression (*a*); ridge on the posterior side of the last (*b*); and cartilage fulcrum (*c*). Byers's Quarry.
18, 19. — — Interior of both valves (twice the natural size) of a young individual; testiferous. Byers's Quarry.
20. — — Right valve (natural size) of a smooth variety; testiferous. Byers's Quarry.

Fig.

21. Leda Vinti, *King*. Right valve, natural size; testiferous. Byers's Quarry.

22. — — Cast of a right valve (twice the natural size), showing muscular impressions. Byers's Quarry.

23. Schizodus obscurus, *J. Sowerby*. Left aspect; cast (natural size) showing impressions of the anterior and posterior adductor muscles (*a*, *b*); pallial muscles (*c*); and visceral muscles (*d*, *e*). Garforth Quarry.

24. — — Right aspect (natural size) of a cast. Garforth Quarry.

25. Schizodus truncatus, *King*. Right aspect (natural size) of a testiferous specimen. Tunstall Hill.

26. — — Umbonal aspect of the same.

27. — — Right valve (natural size) of a testiferous specimen. Tunstall Hill.

28. — — Right valve (a little enlarged) of a testiferous specimen, showing marks of colour. Tunstall Hill.

29. — — Representation of the dental system:

A, Left valve.

B, Right valve.

a, Tooth fitting into pit, *a**

b, Pit for tooth, *b**

c, Cleft tooth fitting into the triangular space, *c**

d, Pit for tooth, *d**

e, Tooth for pit, *e**

f, Cartilage fulcra.

(The numeral belonging to this figure has been inadvertently omitted. The letter *B* for the left valve, has been by mistake placed opposite to the specimen at figure 31).

30. Schizodus rotundatus, *Brown*. Cast, twice the natural size. Red Marls of Newton, near Manchester. Mr. E. W. Binney's specimen.

(The figure makes the specimen appear more perfect than it really is.)

31. Schizodus Schlotheimi, *Geinitz*. Cast (natural size) of right valve. Marsden.

32? — — Left aspect (natural size) of a cast, with portions of the shell remaining on the lower half. Mr. E. W. Binney's specimen.

G.B. Sowerby Junr.

PLATE XVI.

Fig.

1. Astarte Vallisneriana, *King*. Gutta-percha cast of the right valve, natural size. The original is from Whitley.
2. Astarte Tunstallensis, *King*. Right valve (twice the natural size) of a testiferous specimen. Tunstall Hill.
3. Allerisma elegans, *King*. Right aspect of a cast (natural size) showing impressions of the anterior and posterior adductor muscles (*a* and *b*); and sinus (*c*) in the pallial line. Humbleton Hill.
4. — — Umbonal aspect (natural size) of a cast. Humbleton Hill. Belonging to Mr. J. de C. Sowerby.
5. — — Magnified view of an impression of the pimples on one of the valves. Whitley.
6. Psammobia (?) sub-papyracea, *King*. Cast of right valve, nearly twice the natural size. Humbleton Hill.
7. Solemya biarmica, *de Verneuil*. Left valve (a little enlarged) of a testiferous specimen. Humbleton Hill.
8. Solemya Phillipsiana, *King*. Cast (a little enlarged) of left valve. Humbleton Hill.
9. Chiton Loftusianus, *King*. Cephalic valve, a little enlarged; testiferous. Tunstall Hill.
10. — — Caudal valve, a little enlarged; testiferous. Tunstall Hill.
11, 12, 13. — Intermediate valves, a little enlarged; testiferous. Tunstall Hill.
14. — — Left aspect (twice the natural size) of an intermediate (testiferous) valve, showing area (*a*), and granulated sculpturing. Tunstall Hill.
15. Rissoa Leighi, *Brown*. Cast, four times the natural size. Red Marls, Collyhurst, Manchester. Mr. Binney's specimen.
16. Turbo Permianus, *King*. Gutta-percha cast, nearly twice the natural size. Original from Silksworth.

    (There are slight indications of spiral ribs (which, I believe, are purely accidental) on the fossil; but they are too strongly represented in the figure.)
17. Rissoa Gibsoni, *Brown*. Cast, four times the natural size. Red Marls, Collyhurst, near Manchester. Mr. Bowerbank's specimen.

    (The longitudinal ribs copied by the engraver are, I believe, purely accidental.)

Fig.

18. Rissoa obtusa, *Brown*. Cast, nearly thrice the natural size. Red Marls, Collyhurst, near Manchester. Mr. E. W. Binney's specimen.

19, 20. Turbo Mancuniensis, *Brown*. Thrice the natural size; testiferous. Tunstall Hill.

21, 22. Turbo helicinus, *Schlotheim*. Thrice the natural size; testiferous. Tunstall H.

23, 24. Turbo Thomsonianus, *King*. Thrice the natural size; testiferous. Tunstall H.

25, 26. Turbo Taylorianus, *King*. Nearly twice the natural size; testiferous. Tunstall H.

27, 28. Natica Leibnitziana, *King*. Thrice the natural size; testiferous. Tunstall H.

29. Natica minima, *Brown*. Thrice the natural size; cast. Red Marls, Collyhurst, near Manchester. Mr. E. W. Binney's specimen.

(This specimen served Captain Brown as the original of the species.)

30. Loxonema fasciata, *King*. Twice the natural size; testiferous. Tunstall Hill.

31. Loxonema Geinitziana, *King*. Twice the natural size; testiferous. Humbleton Hill.

32, 33. Macrocheilus symmetricus, *King*. A little more than twice the natural size; testiferous. Tunstall Hill.

PLATE XVII.

Fig.

1, 2. Pleurotomaria antrina, *Schlotheim*. Testiferous; natural size. Tunstall Hill.

3, 4. Pleurotomaria Tunstallensis, *King*. Testiferous; natural size. Tunstall Hill.

5. — — Magnified view of the apical whorls of a testiferous specimen, showing spiral striæ and sutural plications. Tunstall Hill.

6. — — Elongated variety, natural size; testiferous. Tunstall Hill.

7, 8. Pleurotomaria Linkiana, *King*. Rather enlarged; testiferous. Humbleton Hill.

9. Pleurotomaria nodulosa, *King*. A little enlarged; testiferous: *a*, the slit. Tunstall Hill.

10, 11, 12. Euomphalus Permianus, *King*. Thrice the natural size; testiferous. Tunstall Hill.

13. Nautilus Frieislebeni, *Geinitz*. Cast (natural size) showing external face of the outer whorl. Humbleton Hill.

14. — — Lateral view of the last specimen: *a*, the siphonal sheath.

15. — — Inner face of the outer whorl of the same: *a*, the siphonal sheath.

16. — — Longitudinal section (enlarged) of a testiferous specimen, showing the siphonal sheath (*a*) passing through the septa. Humbleton Hill.

17. Nautilus Bowerbankianus, *King*. Lateral aspect (natural size) of a testiferous specimen. Tunstall Hill.

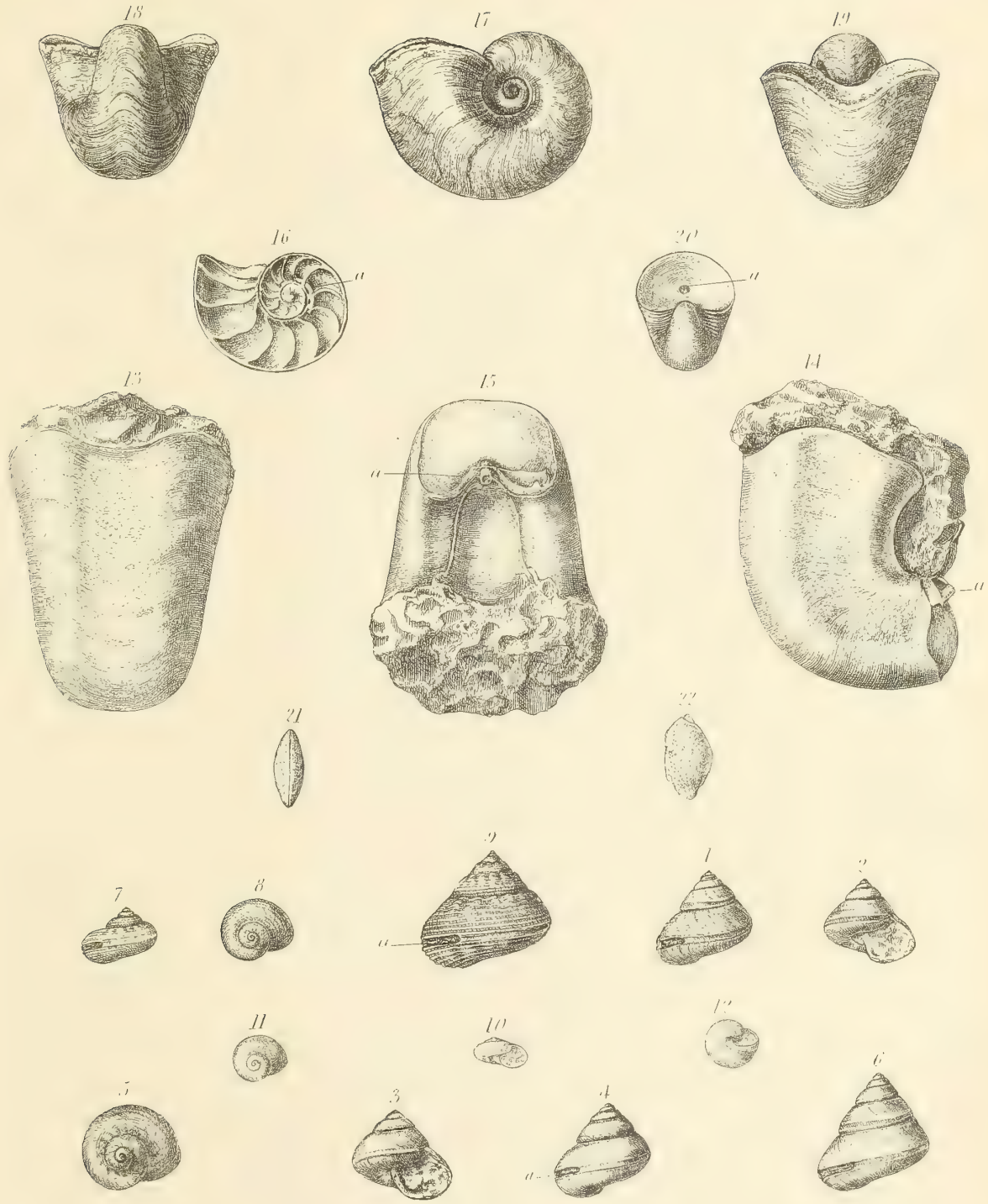
18. — — Posterior aspect of the last specimen.

19. — — Anterior aspect of the same.

20. — — Nucleal whorls (twice the natural size) showing a septum perforated by the siphonal sheath (*a*). Tunstall Hill.

21. Bairdia curta, *M'Coy*. Cast; magnified nine times. Dorsal aspect; valves united. Humbleton Hill.

22. — — Lateral aspect of the same specimen; right valve upwards.



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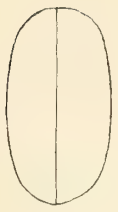
TAB. XVIII.

Fig.

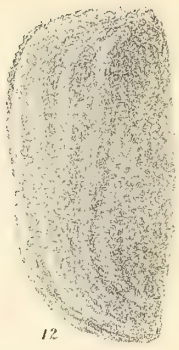
1. Dithyrocaris Permiana (× 50).
   - *a.* Left valve.
   - *b.* Profile.
   - *c.* Anterior aspect of two valves closed—from a worn cast.
   - *d.* Cast of a carapace, the upper valve removed, the lower remaining, but worn at one extremity.
2. Cythere Morrisiana (× 25).
   - *a.* Perfect carapace, right valve upwards.
   - *b.* Dorsal aspect.
   - *c.* Anterior aspect.
3. Bairdia curta (× 30).
   - *a.* Perfect carapace, left valve upwards.
   - *b.* Dorsal aspect.
   - *c.* Anterior aspect.
4. Cythere Geinitziana (× 25).
   - *a.* Perfect carapace, right valve upwards.
   - *b.* Dorsal aspect.
   - *c.* Anterior aspect.
5. Cythere elongata (× 50). Perfect carapace.
6. Cythere Kutorgiana (× 50). Cast of carapace, the left valve removed, the other remaining, its edge visible.
7. Bairdia gracilis (× 50). Worn cast of carapace.
8. Cythere biplicata (× 50). Cast of carapace, one valve removed, the edge of the other visible.
9. Cythere inornata (× 50). Perfect carapace, left valve upwards.
10. Cythere acuta (× 50). Perfect carapace, left valve upwards.
11. Cythere nuciformis (× 50).
    - *a.* Perfect carapace.
    - *b.* Dorsal aspect.
    - *c.* Anterior aspect.
12. Dithyrocaris glypta (× 40). Left valve.
13. Serpula (?) pusilla (× 25).
    - *a.* Perfect.
    - *b.* Perfect.
    - *c.* Central coil.
    - *d.* Transversely fractured, showing the broken ends of the outer coils, 1, 2, 3, 4, 5.

1.a

1.b


1.c.

1.d.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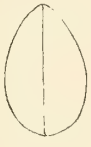
2.a

2.b.


2.c.

3.a

3.b.

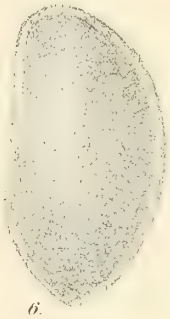
3.c.

4.a

4.b

4.c.

5.


6.

7

8

9.

10

11.a

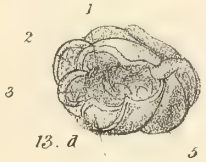
11.b

11.c

13.c.

13.a.

13.b.



13.d

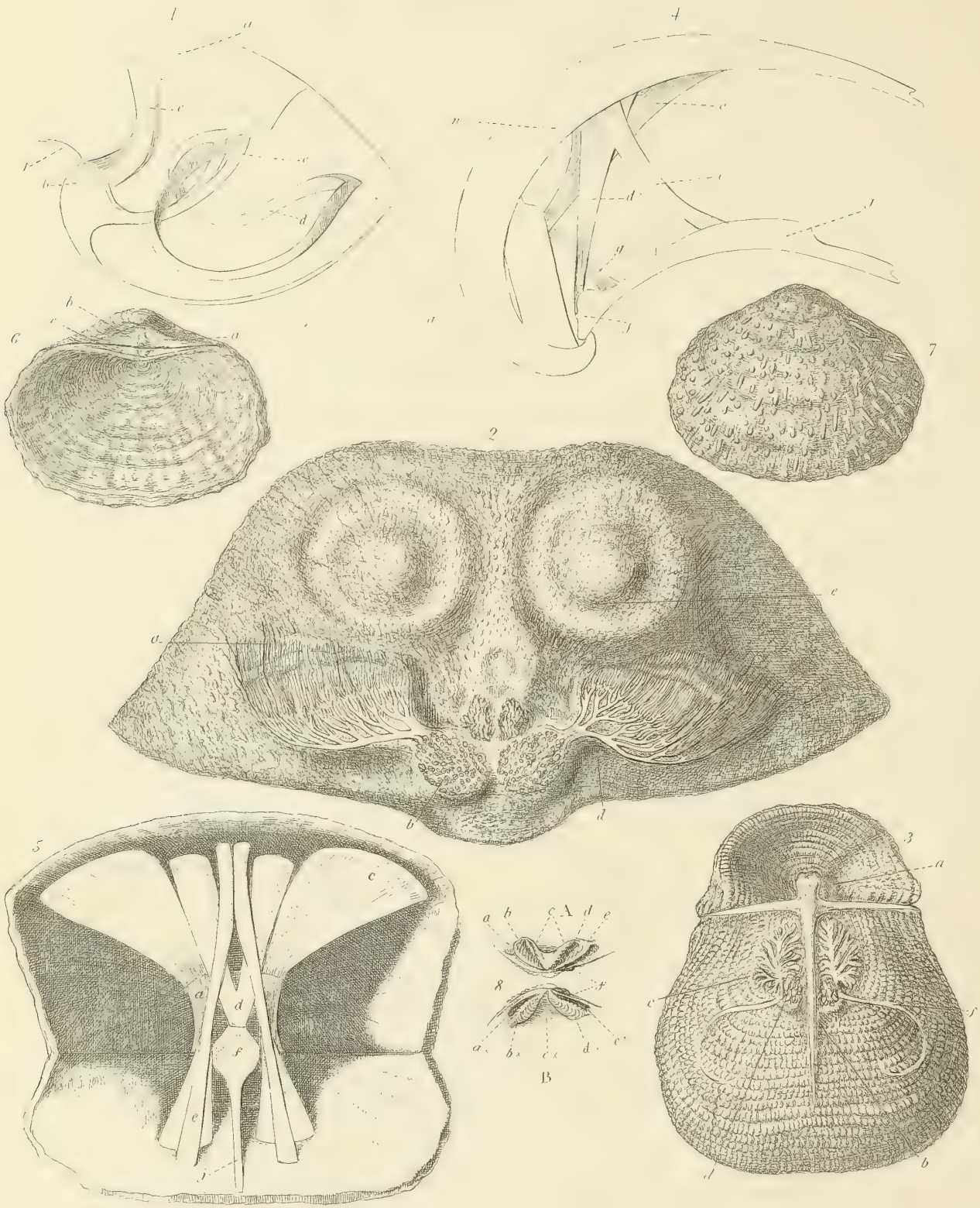


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PLATE XIX.

Fig.

1. Strigocephalus Burtini, *Defrance*. Diagram of a longitudinal section exhibiting the internal structures: *a*, ventral median plate; *b*, crural base; *c*, crura of the loop; *d*, loop; *e*, cardinal muscular fulcrum; *f*, situation of the foramen in the area. The original specimen is from the Devonian system of the Eifel.

2. Productus giganteus, *Martin*. Cast of the large valve, natural size: *a*, impressions of the superior pedicle muscles; *b*, ditto of cardinal muscles; *c*, ditto of valvular muscles; *d*, ditto of the veins nourishing the superior pedicle muscles; *e*, ditto of labial appendages. Carboniferous limestone, Lowick, Northumberland.

   (The letter *c*, referring to the valvular muscular impressions—viz., the pair of small ones immediately behind those of the cardinal muscles *b*—has been inadvertently omitted).

3. Productus semireticulatus, *Martin*. Figure (natural size) of the inner surface of the flat valve, and the inside of the umbone of the large valve; testiferous. The former showing the cardinal muscular fulcrum (*a*); median plate (*b*); impressions of the posterior divisions of the valvular muscles (*c*); ditto of the anterior divisions (*d*); and reniform impressions (*f*). Carboniferous Shale, Redesdale, Northumberland.

4. Productus giganteus, *Martin*. Diagram of a longitudinal section (left half of the shell), exhibiting a restoration of the muscular system: *a*, pedicle mass; *c*, superior pedicle muscle; *d*, cardinal muscle; *e*, valvular muscle; *f*, cardinal muscular fulcrum; *g*, inferior pedicle muscle; *j*, dorsal median plate; *n*, longitudinal section of the large valve.

   (The dotted line connecting the letter *a* with the pedicle mass—i. e., the part in the inside of the umbone—has been unintentionally omitted).

5. — — Diagram of a transverse section (looking within the umbonal region) exhibiting a restoration of the muscular system.

   (The letters in last figure agree in their references with those of the present figure. To prevent confusion, the inferior pedicle muscle (*g*) of last figure is not represented).

Fig.

6. Strophalosia Gerardi, *King*. Small valve, &c., (natural size) of a testiferous specimen: *a*, area of large valve, with its deltidium or closed fissure (*b*); *c*, area of small valve.

(This specimen was collected by the late Dr. Gerard in crossing the boundary of Ladâkh and Bis-áhár in the Himalayas, at an elevation of 17,000 feet above the level of the sea).

7. — — Large valve of the last specimen.

8. Trigonia margaritacea, *Lamarck*. Enlarged view of the dental system for the purpose of comparing it with its homologue in *Schizodus truncatus*.

A, Left valve.

B, Right valve.

a, Ridge fitting into the groove, *a**

b, Groove for the ridge, *b**

c, Cleft tooth fitting into the triangular opening, *c**

d, Groove for the ridge, *d**

e, Ridge fitting into the groove, *e**

f, Cardinal muscular fulcra.

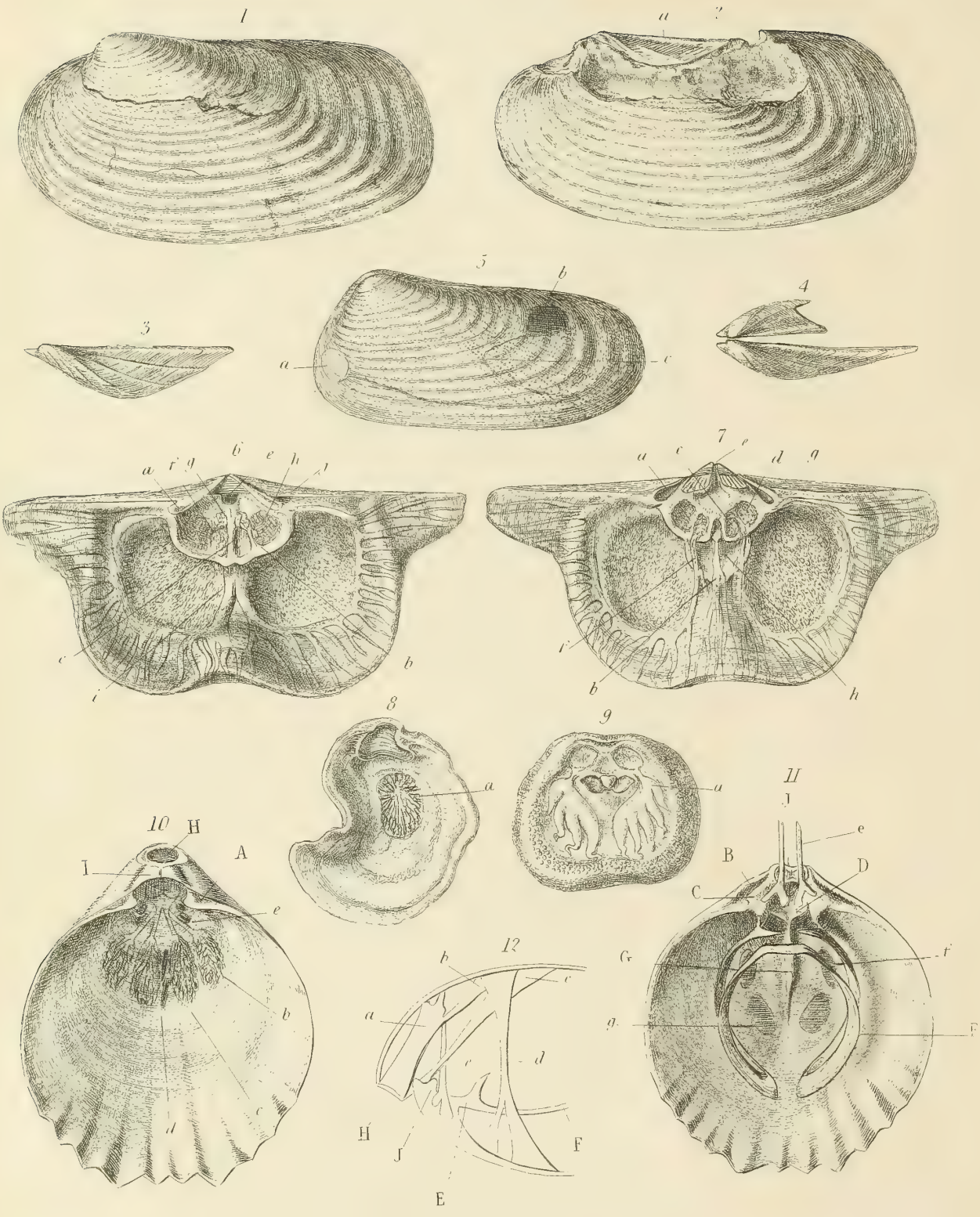

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PLATE XX.

Fig.

1 Edmondia sulcata, *Phillips*. Left aspect (natural size) of a cast. Carboniferous Limestone, Redesdale, Northumberland.

2. — — The same specimen with the umbone removed (by the dark line on the latter figure), showing the left cartilage muscular fulcrum (*a*).

3. — — The left cartilage muscular fulcrum enlarged.

4. — — Both cartilage muscular fulcra (enlarged), as seen on the specimen at fig. 2, when looking on its dorsal aspect.

5. Allerisma sulcata, *Fleming*. Left aspect (natural size) of a cast, showing impressions of the anterior and posterior adductor muscles (*a*, *b*); sinus in the pallial line (*c*); and pimples radiating over the posterior half of the shell. Carboniferous Shale, Redesdale, Northumberland.

6. Leptæna analago, *J. de C. Sowerby*. Foraminiferous valve, twice the natural size: testiferous. *a*, teeth; *b*, saucer-shaped muscular fulcrum; *c*, ventral median plate; *d*, fissure; *e*, foramen; *f*, (?) cardinal muscular impressions; *g*, (?) valvular muscular ditto; *h*, superior pedicle muscular ditto; *i*, primary trunks of vascular system; *j*, area. Carboniferous Shale, Redesdale, Northumberland.

(The letter *d* referring to the fissure—that is, the triangular opening between the teeth *a*—has been inadvertently omitted.)

7. — — Imperforate valve. *a*, dental sockets; *b*, dorsal median plate; *c*, impressions of the anterior divisions of the valvular muscles; *d*, ditto of the posterior divisions; *e*, cardinal muscular fulcrum (divided); *f*, primary trunks of the vascular system passing out from between the divisions of the adductor muscular impressions; *g*, area. Same locality as last.

(The reference letter, *h*, is cancelled.)

8. Anomia ephippium, *Linnæus*. Upper valve, rather enlarged, to show the dendritic character of the impression of the stopper muscle (*a*).

9. Criopus turbinatus, *Poli*. Attached valve (enlarged), showing the digitated genito-vascular impressions (in relief), *a*.

PLATE XX.

Fig
10. Terebratula Australis, ? *Quoy et Gaim.* Perforate valve, twice the natural size.
11. — — Imperforate valve of the same.
12. — — Diagram of a longitudinal section (left half of the shell), representing the muscular system, &c., of the same.

(The various structures in the three figures have the same reference letters.)

A, Teeth or condyles.
B, Dental sockets.
C, Socket plates.
D, Crural base.
E, Crura of the loop.
F, Loop.
G, Dorsal median plate.
H, Foramen.
I, Deltidium (divided).
J, Cardinal muscular fulcrum.
a, Pedicle.
b, Superior pedicle muscles.
c, Cardinal muscles.
d, Valvular muscles.
e, Inferior pedicle muscles.
f, Impressions of the posterior divisions of the valvular muscles.
g, Do. of the anterior divisions.

PLATE XXI.

Fig.

1. Palæoniscus comtus,[1] *Agassiz.* $\left.\begin{matrix} a \\ b \end{matrix}\right\}$ Scales magnified. Marl-slate, Thrislington Gap. Belonging to the Natural History Society of Northumberland, Durham, and Newcastle-on-Tyne. Presented by Mr. T. Hodgson.
2. Palæoniscus longissimus, *Agassiz.* *c*, Scale magnified. Marl-slate, Thrislington Gap. Natural History Society of Northumberland, Durham, and Newcastle-on-Tyne. Mr. T. Hodgson.

[1] All the figures are of the natural size.

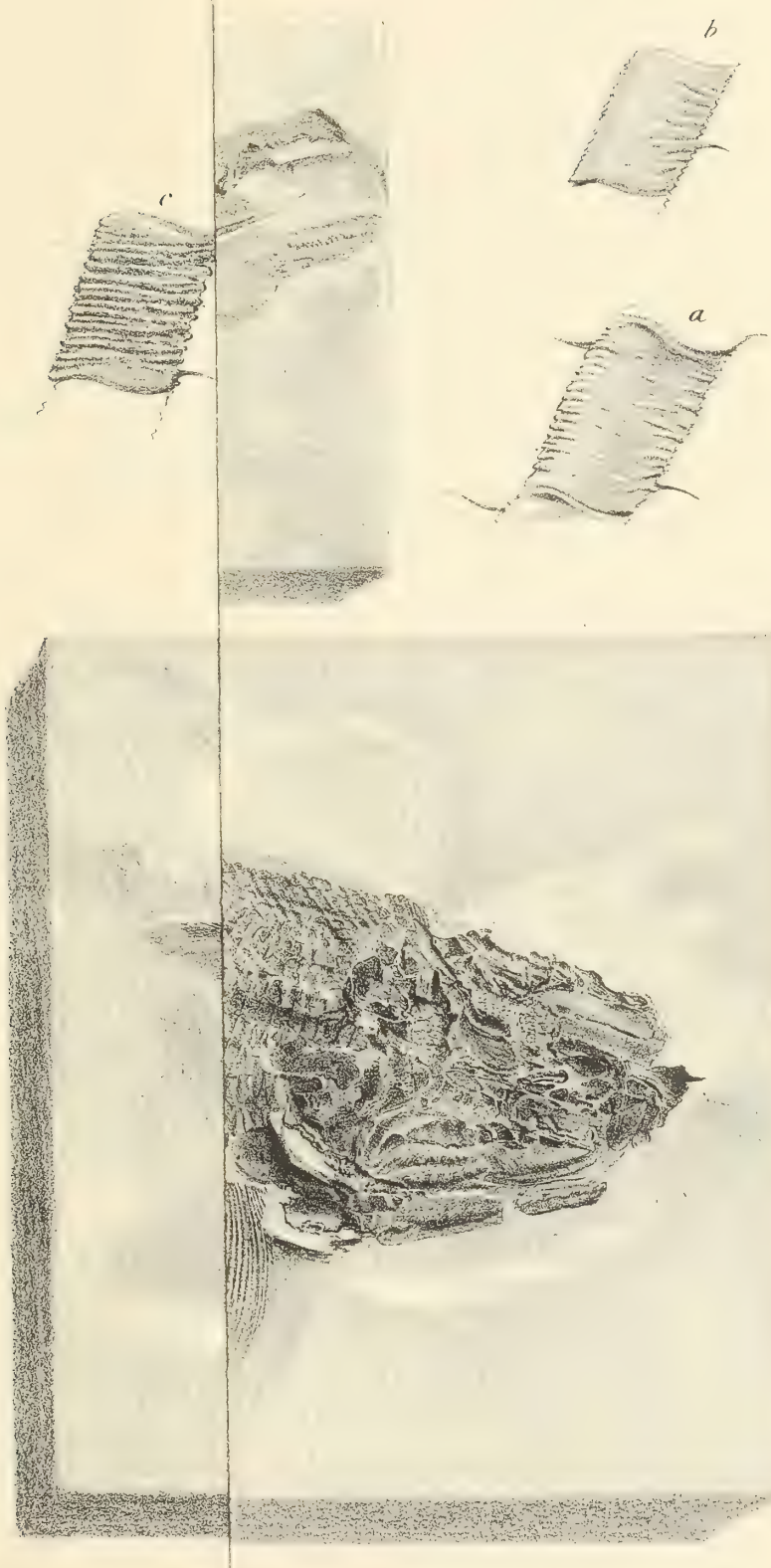

Fig. 1.

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Fig 2

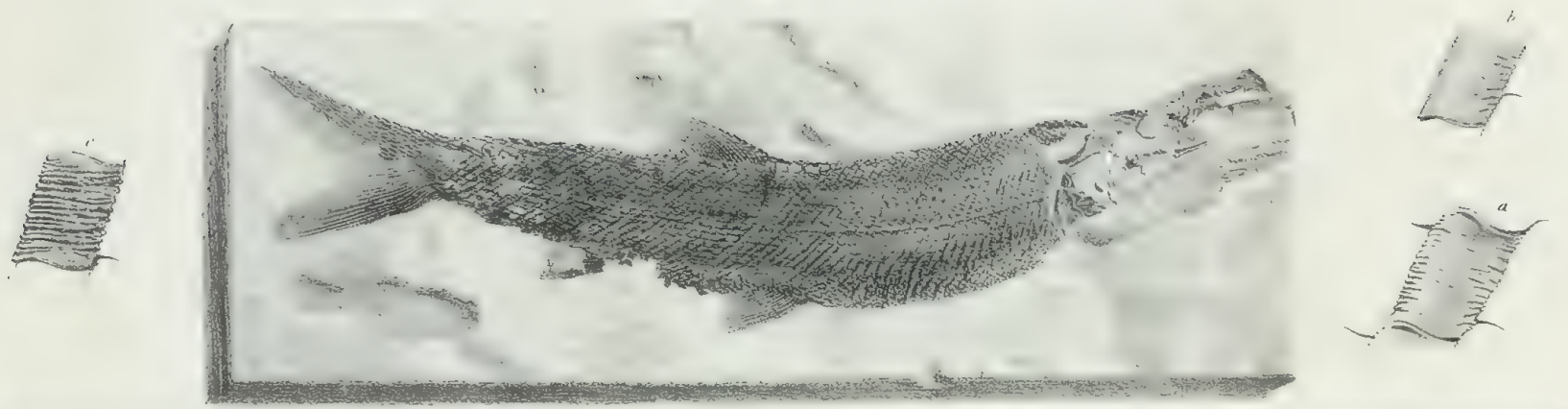

Fig 1

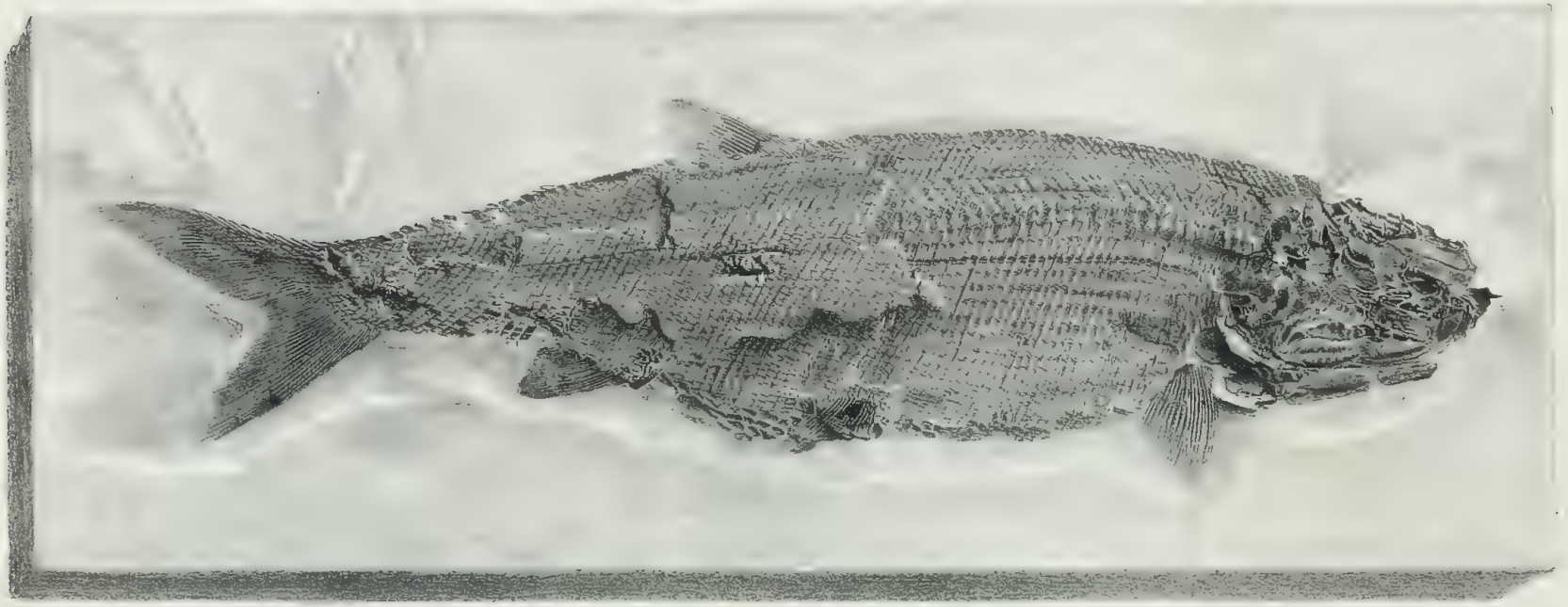

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PLATE XXII.

Fig.

1. Palæoniscus elegans, *Sedgwick*. *a*, Under surface of scales magnified. Marl-slate, Aycliff. Nat. Hist. Soc. of Northumberland, Durham, and Newcastle-on-Tyne.
2. Palæoniscus macropthalmus, *Agassiz*. Copied from Mr. Dinkel's original drawing of Mr. Ripley's specimen.
3. Palæoniscus glaphyrus, *Agassiz*. Museum of the Yorkshire Philosophical Society.
4. Palæoniscus glaphyrus ? or N. Species ? *b*, Under surface of scale magnified. Marl-slate, Whitley. Nat. Hist. Soc. of Northumberland, Durham, and Newcastle-on-Tyne.

Fig 4.

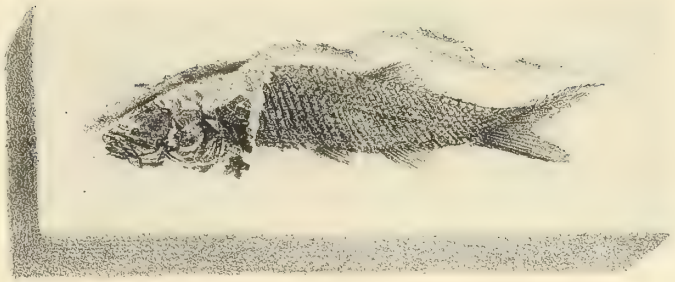

Fig 2.

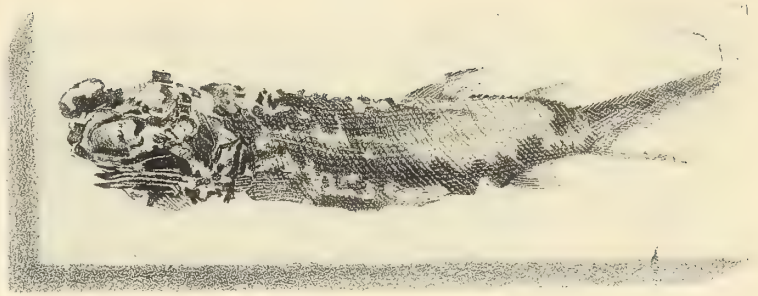

Fig. 3.

Fig. 1.

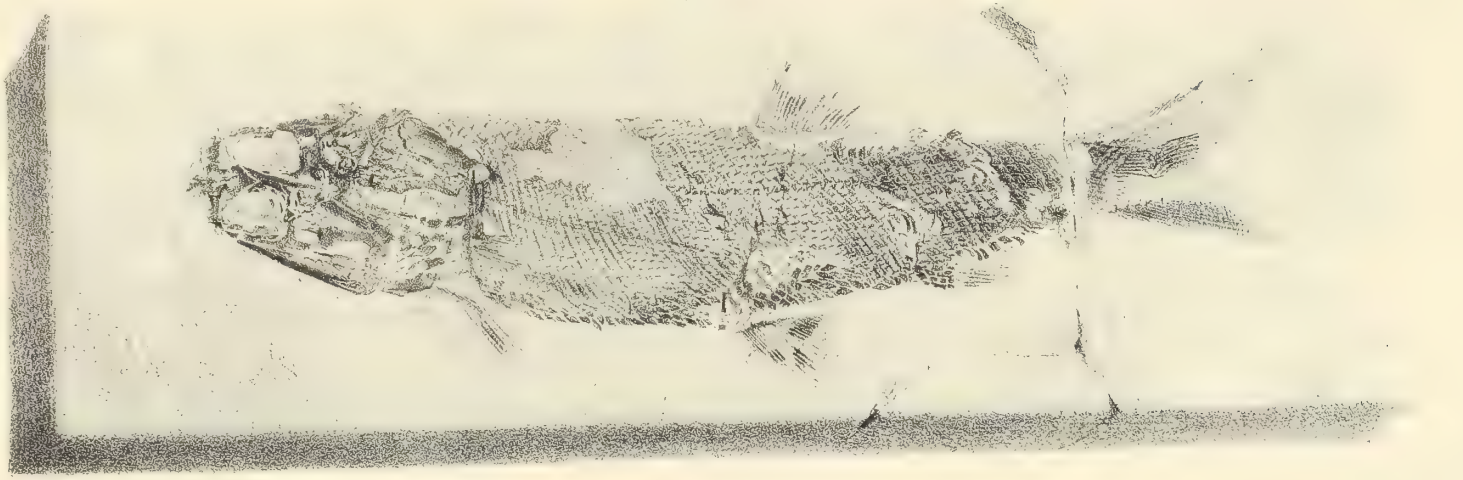

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PLATE XXIII.

Fig.

1. Pygopterus mandibularis, *Agassiz*. *a*, Outside of scale magnified; *b*, under surface of ditto. Museum of the Yorkshire Philosophical Society.

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PLATE XXIV.

Fig.

1. Pygopterus latus, *Egerton*. *a*, Scale magnified. Marl-slate, Ferry Hill. Cabinet of Sir Philip de Malpas Grey Egerton, Bart., M.P.

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PLATE XXV.

Fig.

1. Acrolepis Sedgwickii, *Agassiz*. *a*, *b*, *c* Scales magnified. Marl-slate, Ferry Hill. Museum of Sir Philip de Malpas Grey Egerton, Bart., M.P.

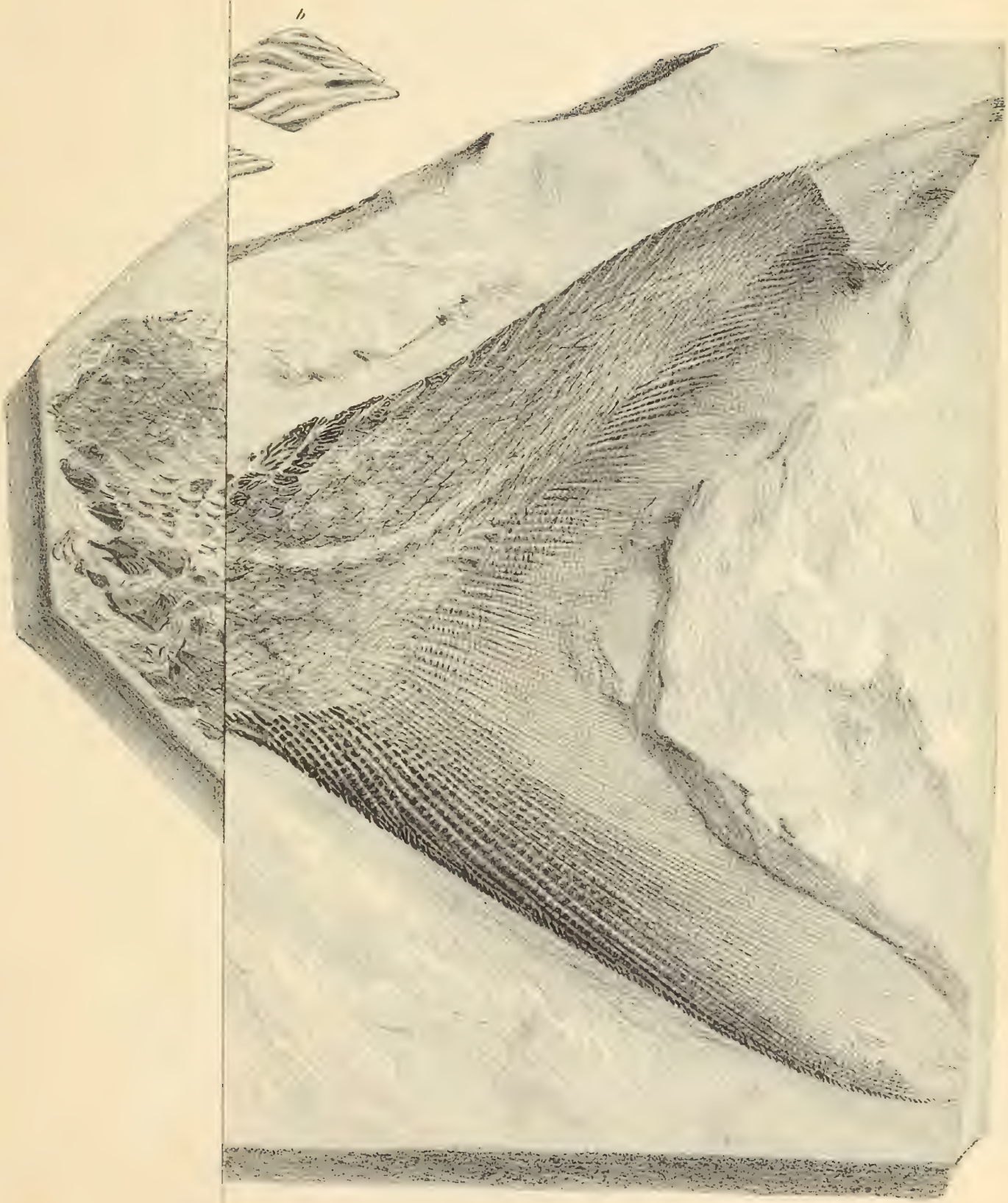

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Fig 1

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PLATE XXVI.

Fig.

1. Platysomus macrurus, *Agassiz*. *a*, Under surface of scales, magnified. Marl-slate, Ferry Hill. Museum of the Nat. Hist. Soc. of Northumberland, Durham, and Newcastle-on-Tyne. Procured by Mr. John Jameson.

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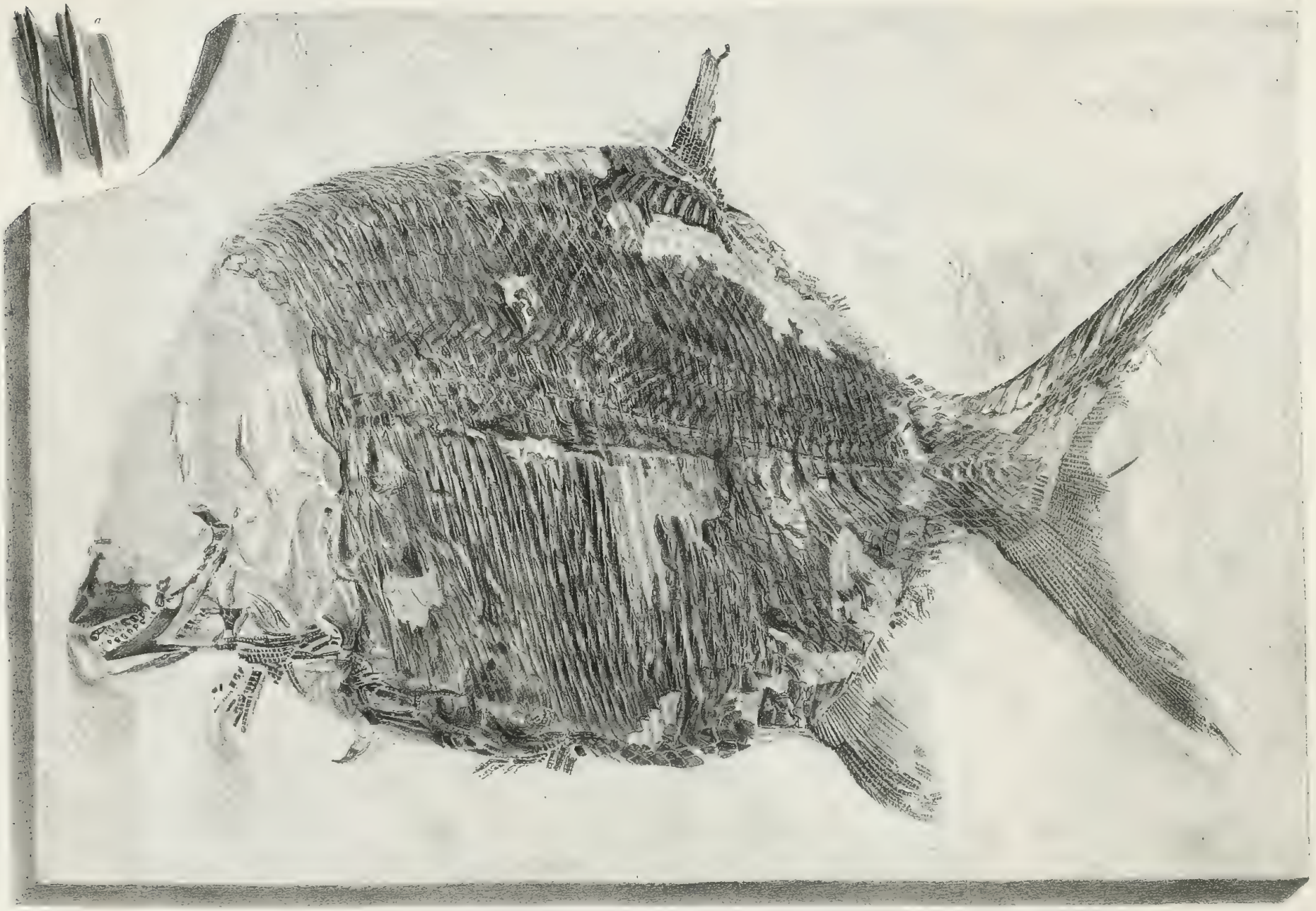
a

PLATE XXVII.

Fig.

1. Platysomus striatus, *Agassiz.* *a*, Flank scale, magnified; *b*, under surface of ditto; *c*, scale from the lateral line, magnified; *d*, scale from near the tail, ditto. Marl-slate, Ferry Hill. Cabinets of Mr. J. S. Bowerbank, and Sir Philip de Malpas Grey Egerton, Bart., M.P.

Fig. 1.

Pl. XXVII

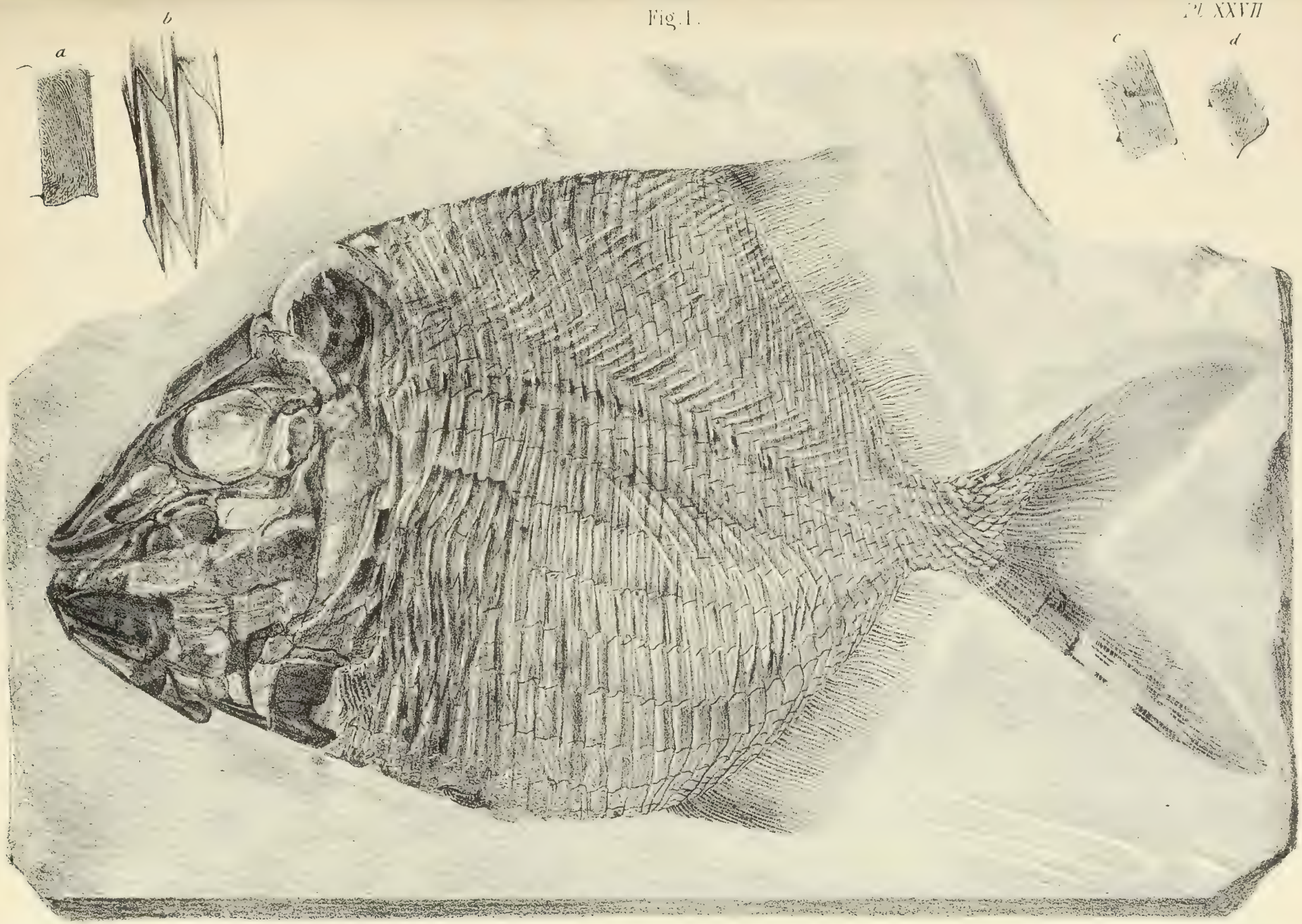

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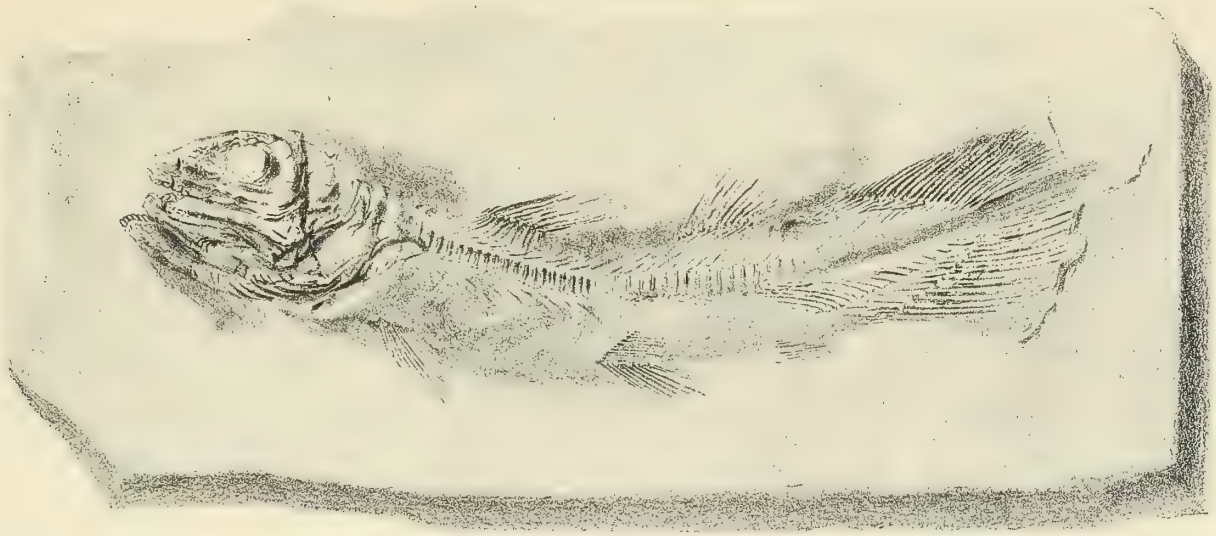
PLATE XXVIII.

Fig.

1. Platysomus striatus, *Agassiz*. Young individual : *a*, scales magnified ; *b*, impressions of ditto. Marl-slate, Thrislington Gap. Museum of the Yorkshire Philosophical Society.

2. Cælacanthus granulosus, *Agassiz*. Young individual. Cabinets of the Earl of Enniskillen, and Sir Philip de Malpas Grey Egerton, Bart., M.P.

Fig. 2.



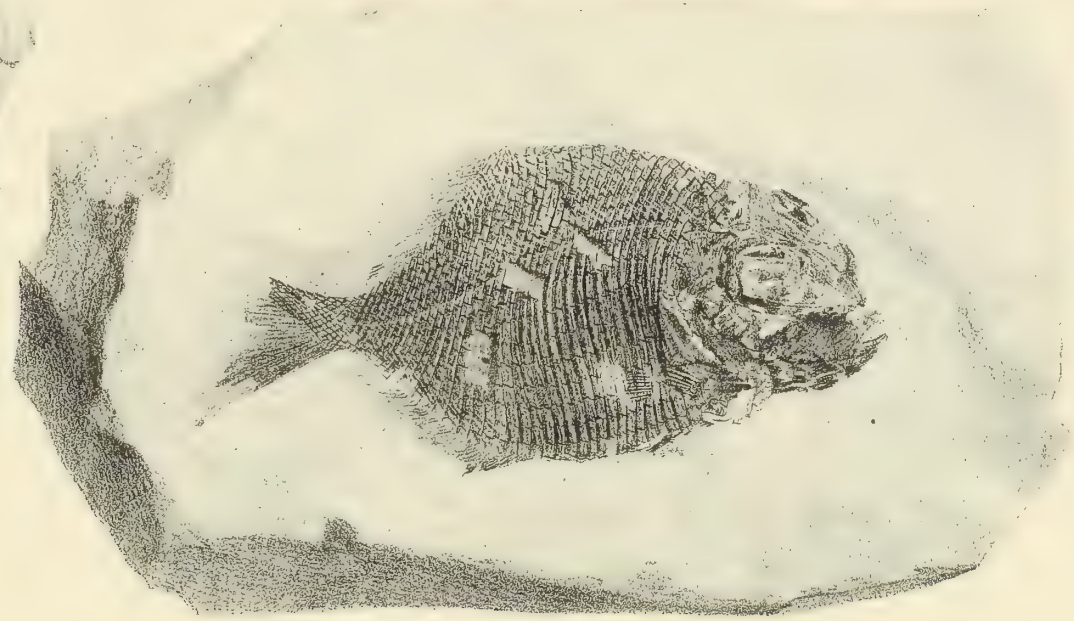


Fig. 1.

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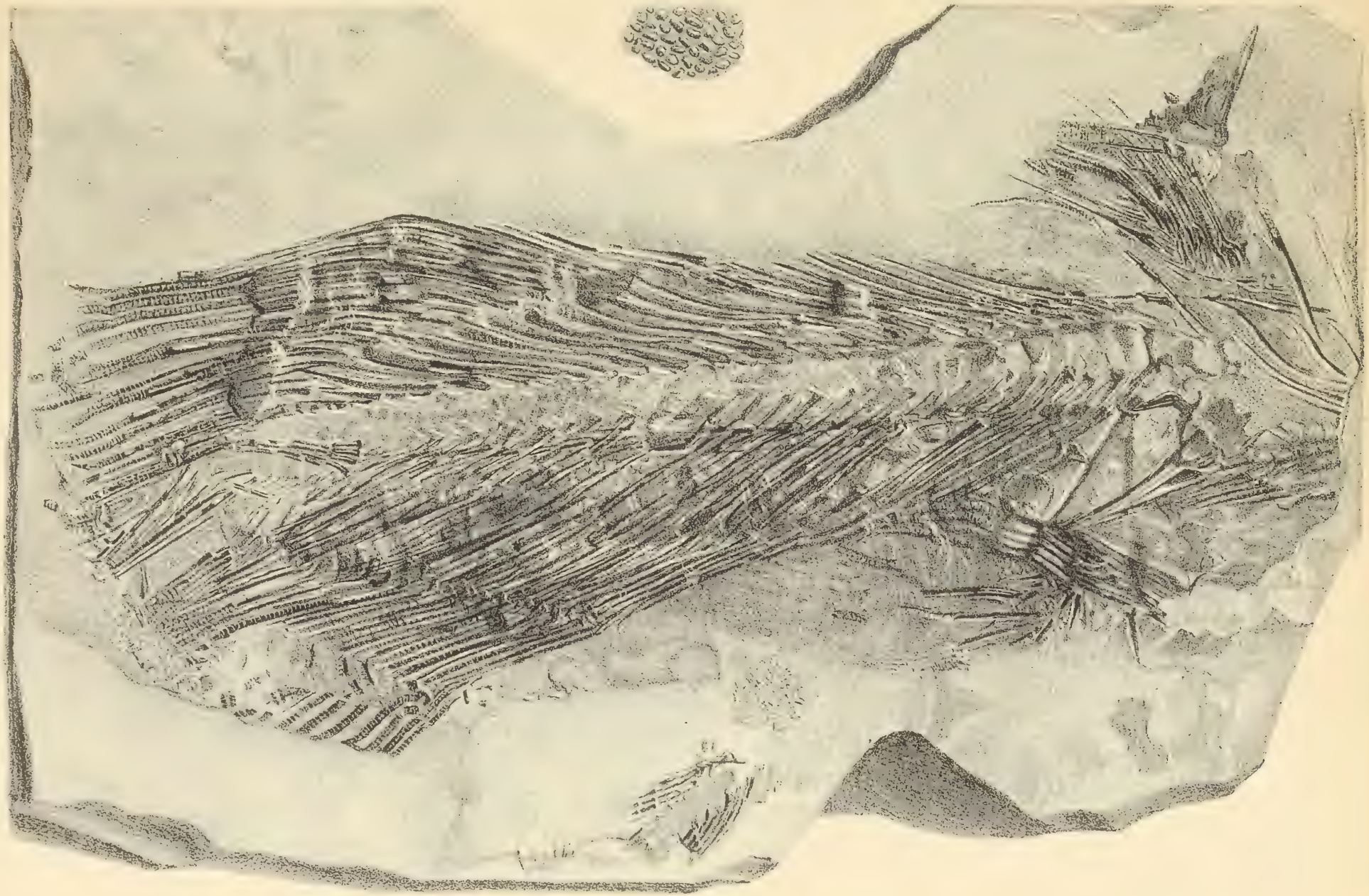
PLATE XXVIII*.

Fig.

1. Cœlacanthus caudalis, *Egerton*. Marl-slate, Ferry Hill. Cabinet of Sir Philip de Malpas Grey Egerton, Bart., M.P., &c.
2. — — Magnified figure, showing granulated character of the scales.

Fig 2



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